POWER TOPICS CROSS-INDEX

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
INSTRUMENTS & CONTROL
PIPING SYSTEMS
MECHANICAL TRANSMISSION
POWER MISCELLANY

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POWER

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SEPTEMBER, 1937

Welding steam and water lines of Waterside's "top" 480
How to maintain air compressors, final of a series 484
Solving the high-pressure bypass problem at West End 486
Gasoline standby supplements dieselized pumping plant 490
A query concerning the radial, double-rotation turbine 492
Variable-speed motors solve pumping problem at Omaha 494
Dial thermometers, what they are and what they do—II 496
Water conditions govern reliability of evaporators 499
Construction and operation of friction clutches—I 500
Ultra-modern practice for deriving byproduct power—II 502
Choosing between district and self-generated steam 504
Two methods of controlling condensate and feedwater 506
All-welded steel stack for Fisk Station, Chicago 507
Relining a penstock-valve cylinder with metal spray 509
Force feeding in three typical industrial plants 511
Photostory—hydrogen cooling of turbine-generators 512
Data Sheet 61—wire and fuse sizes for motor circuits 514
Gas-fired diesel in Texas; gas engines at Toledo 515
Diesels in England—the trends in plant design abroad 517
Variable-speed condensing turbine drives compressor 519

DEPARTMENTS

Speaking of Power 510
Engineers' Books 523
Readers' Problems 525
News, Straws 532
Practical Aids 520
Current Comment 524
New Equipment 529
George Edwards 538

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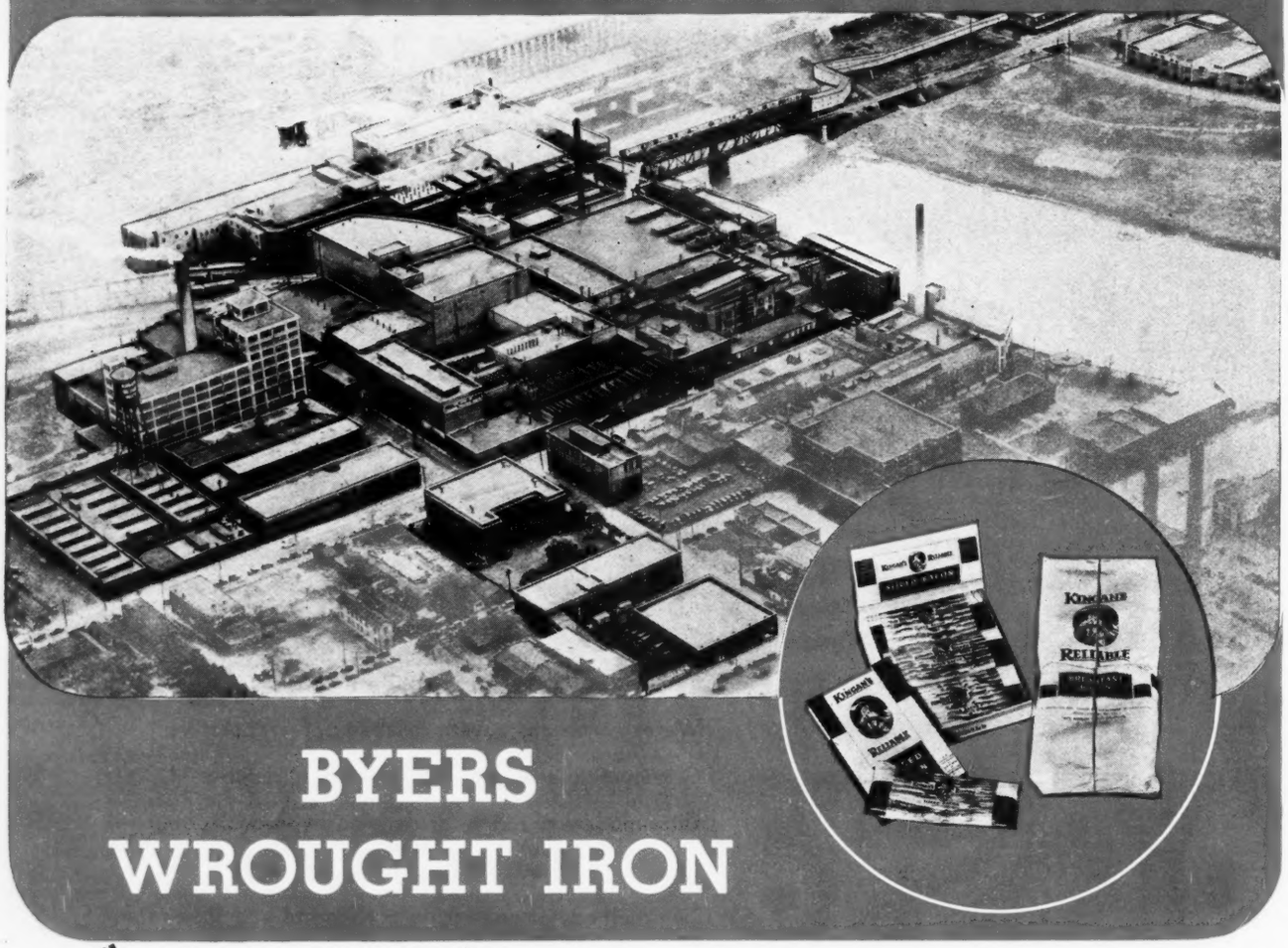

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This information comes under the subject of "Corrosion Studies" and information concerning it may be secured without obligation through our nearest Division Office, or by writing direct to our Engineering Service Department at Pittsburgh. Also ask for the illustrated booklet showing wrought iron's wide use, entitled "Wrought Iron in Industry."

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Power

A McGRAW-HILL PUBLICATION—ESTABLISHED 1882—PHILIP W. SWAIN, EDITOR

Drought Warning

WE HAVE HINTED before that water waste in air conditioning is headed straight for a stone wall. Now we can talk turkey, because the Department of Commerce has just published the facts on 91 cities having more than 100,000 population.

Chicago has the whole of Lake Michigan right in its front yard, and plenty of pumping capacity. Only 16% of the "loop" is air conditioned. Yet on several hot days last summer sewers were so overloaded with cooling water that cellars were flooded. Many other cities face similar troubles.

Overheated citizens of Washington, D. C., sought the cool hand of air conditioning for their fevered brows. Unwilling to pay the full price, many installed water-cooled units without cooling towers. City pumping and sewerage loads mounted—30,000 gal. per day for the neighborhood movie, another 30,000 for a beauty parlor. Then two big installations asked permission to use a quarter million gallons each per day.

There can be only one answer to that sort of thing. Already large new plants in Washington have been warned that their water may be rationed in hot weather if domestic supply is threatened.

You might think that Atlanta, with her safe yield of more than 800 gal. per capita, would have no water worries. Yet Atlanta is now at the end of her rope as far as the water-wasting variety of air conditioning is concerned. She will stay there until she can increase the present 115 gal. per capita capacity of her water-treating system.

Other cities are headed for similar trouble. Chattanooga, Columbus (Ohio), St. Paul, Scranton, South Bend and Louisville are near the limit of their pumping capacity. Baltimore, now using 75% of its delivery capacity, will soon need new sources of raw-water supply. Buffalo, at 73% of capacity, must add facilities for storage, treatment and pumping. Dayton is running at 84% of capacity, El Paso at 94%.

The situation is clear enough; but what can be done about it?

FIRST, water-supply and sewer departments of cities must get busy with plans to increase capacity.

SECOND, it must be made clear to everybody that no possible increase in water or sewerage capacity can handle the ultimate air-conditioning load, if a large fraction of it is to be carried by water-wasting equipment. The wider use of cooling towers (or direct heat removal by air) is inevitable.

THIRD, common sense calls for an immediate air-conditioning survey of every city and town—the listing of every air-conditioning installation, its installed horsepower, tonnage of refrigeration, consumption of water and disposal of that water.

FOURTH, most communities must pass ordinances restricting water waste. Right now 38 cities over 100,000 population are restricting the use of water for air conditioning, or are about to do so. Engineers have often been urged to take a constructive part in public affairs. Here is their opportunity to do a home-town job, to sell local authorities the need for an immediate survey and then help them draft practical protective ordinances.

Finally, the individual engineer must face the music in his private planning. Let him ask himself two questions when he selects his air-conditioning system: 1. "What will be the yearly cost of wasting water, assuming I can get it?" 2. "What will it cost me when I can't get it and therefore have an obsolete air-conditioning plant on my hands?"

Now is the time to face the facts. No amount of wishful thinking is going to produce satisfied air-conditioning customers if they are sold water-wasting systems in regions where the water can't be had two years hence.

(Readers are urged to write to the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C., and ask for "Effect of City Water and Sewerage Facilities on the Market for Air Conditioning Equipment—Market Research Series No. 16." The price is 10c.—*Editor.*)

WELDING AT WATERSIDE

Steam and water lines are arc welded, using "chill rings". Joint are stress relieved in position by induced current, then X-rayed

by

W. S. Morrison and W. J. Angus

Mechanical Plant Engineer *Asst. Mechanical Plant Engineer*
Consolidated Edison Co. of N. Y., Inc.

HIGH PRESSURES combined with high temperatures require a piping joint free from service troubles. This fundamental was given careful consideration at Waterside Station of the Consolidated Edison Co. of N. Y., Inc., for its new 1200—1400-lb., 900-F topping turbine and its two boilers. An elaborate study of various forms of joints showed that no form of flanged joint would stand up for any length of time under high-temperature service, substantiating the general opinion that a full welded joint is the practical answer.

Several designs of welded joints for high-pressure, high-temperature service were tested. Upset ends of pipe, fittings and valves specially machined to true dimensions, and fitted with a special backing ring recessed into the wall at the joint, appeared very good, but the expense was not thought justifiable. In the end, present general practice was followed, using the 45-deg. bevel, butt-welded joint, Fig. 1, for 2-in. pipe and larger, for wall thickness not exceeding ½ in.

All welding was done by d.c. electric-arc fusion method, which made it necessary to use a backing ring ("chill ring") to prevent formation of "icicles" or weld drippings and splatter inside the pipe. At first, we proposed to use a split ring of approximately the same material as the pipe, 2 in. wide and with a spacing rib (continuous or in sections) around the outer circumference at the center of ring width, but after experiments on trial welds, we selected a plain flat split ring 1 in. wide. For pipe smaller than 2 in., where a backing ring is objectionable, fillet-socket joints were used, Figs. 3 and 4.

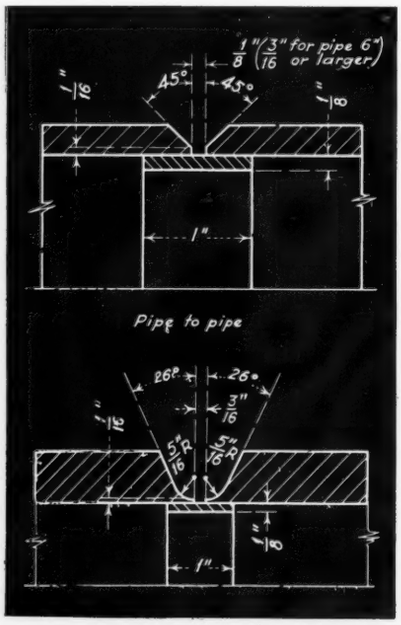
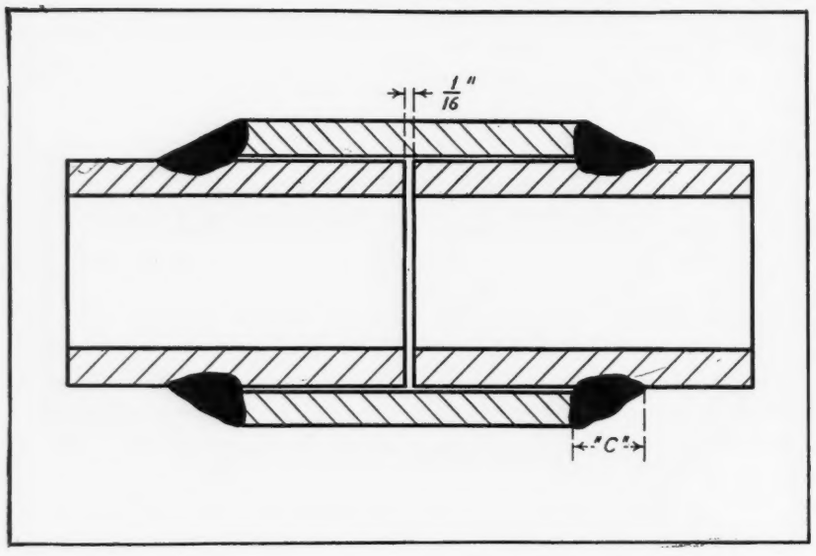


Fig. 1—Joint (pipe to pipe or valve) for 2-in. pipe and larger, if pipe walls are not over ½-in thick

Fig. 2—Joint (pipe to pipe or valve) for pipe walls over ½-in. thick

Fig. 3—Sleeve joint for 1½-in. pipe and smaller



Most Joints Welded

As far as possible, all high- and low-pressure joints were welded on the first unit. Exceptions were made for boiler connections of the 1200-lb., 900-F steam main, high-pressure boiler-feed piping, and the boiler-feed discharge at the pumps. For these connections, "Sarlun" ground-face flanged joints, without gaskets, were used. Other exceptions were made for connections to cast-iron valves and other equipment not provided with welding ends. Main steam piping from discharge ends of the non-return stop-and-check valves has welded joints throughout, including the connection to the turbine throttle valve.

All stop valves on boiler-feed discharge lines (as on the main steam and the 200-lb. bleed and station steam-tie lines) are welded directly into the line. Fig. 5 shows two high-pressure valves welded into the boiler-feed discharge branches at the heaters.

All shop fabrication and field welding of joints was performed by operators proven competent for the work involved by qualification under the rules of the Travelers Indemnity Co. Rules and qualifications are, in general, those of the American Tentative Standard Code for Pressure piping, ASAB-31-1935, with some additional features, such as requiring welders to make a branch connection.

In welding a butt joint in the field, the backing ring was inserted in position in one pipe end and tack welded. The adjoining pipe, valve, or fitting

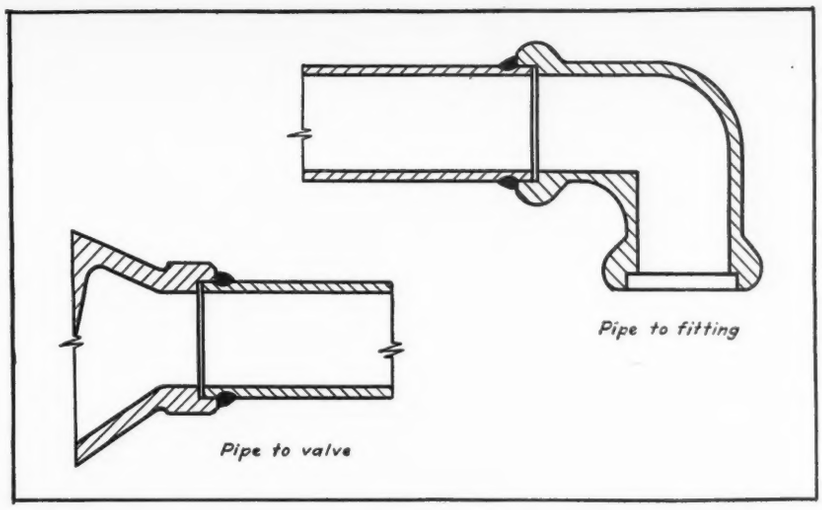


Fig. 4—Fillet-socket joint connects 1½-in. pipe or smaller to valve or fitting

end was then brought into position and slipped over the free end of the backing ring, leaving the proper spacing between meeting ends. Four steel-bar lining-up strips were then tack welded to the meeting ends, Figs. 6 and 7. These held the alignment until the weld was far enough along to permit their removal.

In laying the first bead, extreme care was taken to obtain thorough fusion at the bottom of the joint end and to fuse in all tack welds of the backing ring. To accomplish this without burning through the backing ring requires expert technique.

Coated Rod

All welding was done with covered electrodes and a rod composition suitable to the piping material. A carbon-steel rod with the correct amount of molybdenum was used to weld the carbon-molybdenum alloy-steel piping. Small rods were used to lay in the first bead, since numerous thin beads gave a better weld than a few heavy beads. After each rod was used up and before subsequent beads were applied, a helper thoroughly cleaned each bead by light peening with a hammer and wire brushing.

Allowable mill tolerances (A.S.T.M.) in diameters, out-of-roundness and wall thickness of the pipe gave some difficulty in matching ends for welding. Spaces between pipe wall and backing ring resulted in slag inclusions and other imperfections in the weld. To obtain thorough fusion at the bottom of welds, it was sometimes necessary to machine special backing rings without a split, stepped in some cases, and fitted to the individual adjacent pieces being joined.

Main steam lines (carbon-molybdenum alloy-steel) and carbon-molybdenum valves in the boiler-feed discharge lines required a special procedure to insure sound, ductile welds. Preheating to about 600 F, maintaining heat during welding, and completing the weld without interruption followed immediately by stress-relieving resulted in easier welding and a weld having better physical properties. Fig. 7 shows the set-up used by the turbine manufacturer on main steam piping at the throttle valve. A special resistance wire was wound around joining ends and covered with heavy plastic insulation. After the joint was completely welded, it was covered with additional insulation and current

Fig. 5—High-pressure valves welded into boiler-feed discharge branches at the headers

Fig. 6—Ready for welding at valve and at block Y-branch forging. Backing ring and line-up bars have been tack welded in place

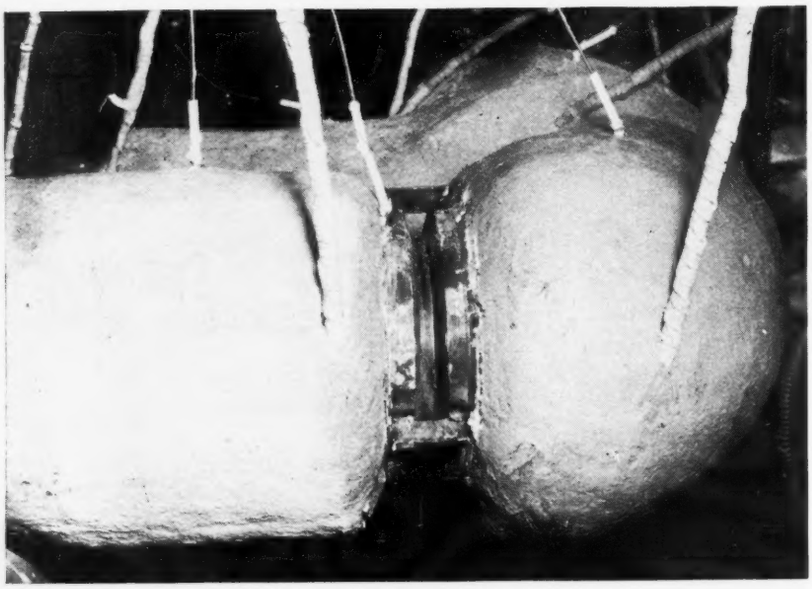


Fig. 7—Rig used by turbine manufacturer for welding carbo-molybdenum alloy-steel main steam line. Resistance wires hold pipe at 600 F during welding. Note backing ring and line-up bars

flow maintained for stress relieving. This procedure assured uniform preheating and maintaining of heat during welding. The insulation covering helps the parts to retain heat, protects the welder, and permits using the same equipment for stress relieving without change or interruption.

This procedure could not be followed in all cases because insulation could not be applied where the electric-induction stress-relieving equipment was used. In such cases, preheating was done with torches. Heat was maintained by the heat of welding and then the inductance collar was immediately clamped in place for the stress-relieving process. All welded joints on the main steam, boiler-feed discharge, and 200-lb. bleed and steam lines, 2½ in. and larger, were stress relived with the inductance collar, Fig. 8, in practically all cases.

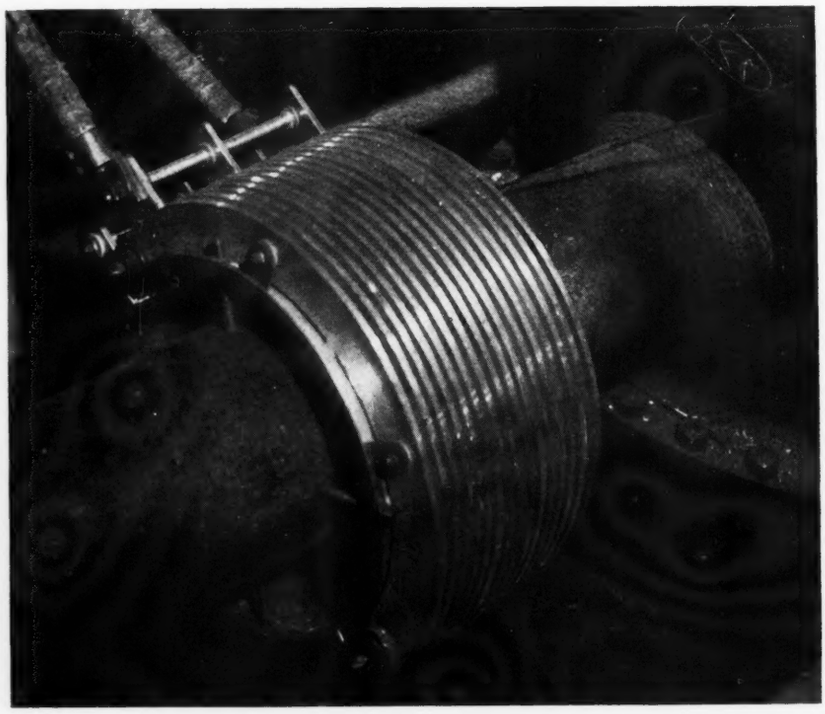


Fig. 8—Stress-relieving collar, clamped around a weld, anneals weld by induced current

While it was found impossible to comply strictly with the Code of Pressure Piping in stress-relieving the weld within a band of the specified width, the procedure adopted was approved. With the inductance collar, maximum temperature in the pipe is at the center of the collar length, temperature falling off on each side. At a center temperature of 1200 F, temperature of a point 4 in. away is 1100 F. It is questionable whether a band as wide as the Code requires is necessary. After investigation, a practice was developed for keeping the weld and parent metal, to 1 in. each side of the weld, at a temperature of 1100 to 1200 F for one hour per in. of pipe-wall thickness. This was done with both carbon and carbon-molybdenum steel, except that twice the time was allowed for "carbonmoly."

The stress-relieving inductance-type furnace was developed jointly by Detroit Edison Co. and its manufacturer, Detroit Electric Furnace Co. It consists of a split helical-coil collar, forming the primary of a low-voltage transformer to be clamped around the pipe, which then becomes the short-circuited secondary.

As soon as possible after completion of a weld, a collar of suitable size was clamped in place and the weld brought up to stress-relieving temperature.

The St. John X-Ray Service, Inc., under contract, made X-ray examination of all large welded joints on main steam, boiler-feed discharge, and 200-lb. bleed and station steam-tie lines. Interpretation and responsibility was placed in the hands of the Service.

X-ray equipment used was unique—an extremely high-powered and highly mobile apparatus designed for use in close quarters under adverse conditions. The transformer and its water-cooling equipment are mounted on a trailer, Fig. 9, then uncoupled and moved into the station to positions as close to the work as possible. 30 ft. of flexible shock-proof, high-tension cable extending from trailer to X-ray tube made it easy to apply the tube in locations otherwise inaccessible.

The 220,000-volt X-ray tube, requiring about 8 milliamp., is especially designed for portability and

Fig. 9—Trailer housing transformers of high-power X-ray equipment was taken into plant close to work

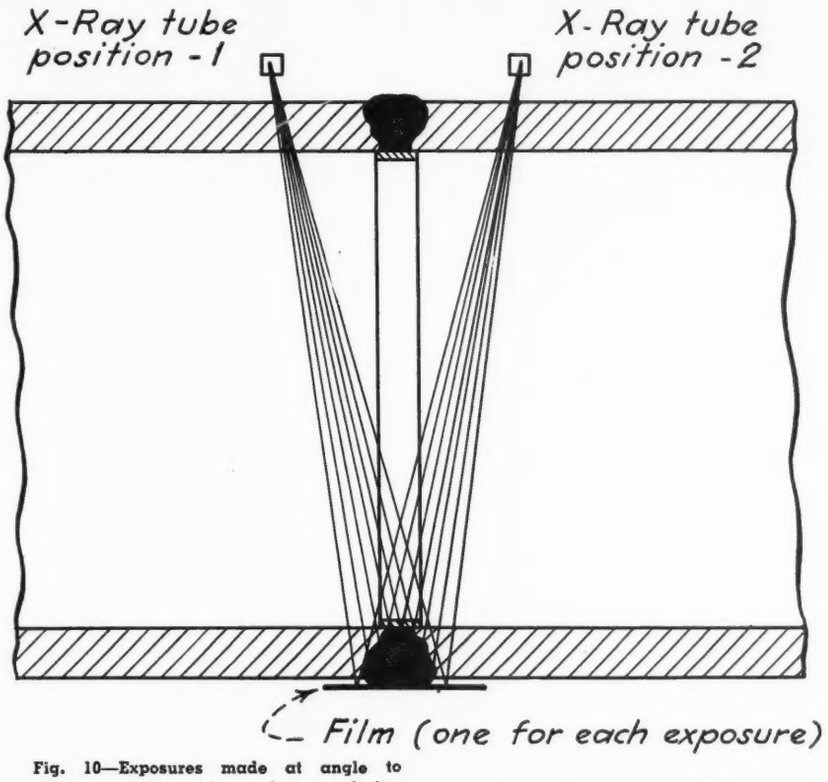


Fig. 10—Exposures made at angle to show up defects along plane of fusion

pipeline welds. Ordinarily, tubes for stationary machines and boiler work are both oil cooled and oil insulated. Since the problem of maintaining oil insulation interferes with portability, this tube is water cooled and air insulated. The anode lead of the armored flexible cable encloses two concentric hoses conveying the cooling water to and from the tube.

The tube, Fig. 11, is mounted in a special shock- and X-ray-proof metal housing. It is designed for a point-source supply of rays and contains a filter to permit only the shortest penetrating rays to pass through the tube-housing window. This gives sharp definition and contrast in the negative. The machine is capable of penetrating 3 in. of steel in 1 min. with proper exposure. Exposures are made on a film contained within the lead-shielded holder, which is strapped in close contact with the pipe at that portion of the weld that is being examined and on the wall of the pipe opposite.

Exposures are taken in pairs, but not simultaneously or on the same film, and a sufficient number are taken to include the entire circumferential weld. Thus, for a 12-in. pipe, six pairs of exposures are taken. The tube is placed slightly to one side of the weld for one pair of exposures, and then slightly to the other side for the second pair, Fig. 10. Rays are focused through the pipe wall adjacent to the tube, so that they pass through the entire weld in the opposite wall.

Satisfactory results were obtained and a number of poor welds detected. With these faults, weld metal was chipped out and the spot rewelded, stress relieved and re-examined by X-ray. Interpretation of exposures was based upon experience and knowledge of exposure conditions and weld design. Angularity of exposures in pairs aids in the determination of fault position as well as its magnitude. Penetrameters or "tell-tales" were not used by the X-ray operator to determine depth of a fault. Instead, he used a set of comparative exposures on samples.

Because of the greater wall thickness (in this case $4\frac{5}{8}$ in.), gamma ray was used for examination of one joint on the 20-in. main steam connection to the turbine throttle valve. Radium, centered and held in a special frame, was inserted through the disassembled throttle valve into the interior of the body and placed in line with the circumferential weld.

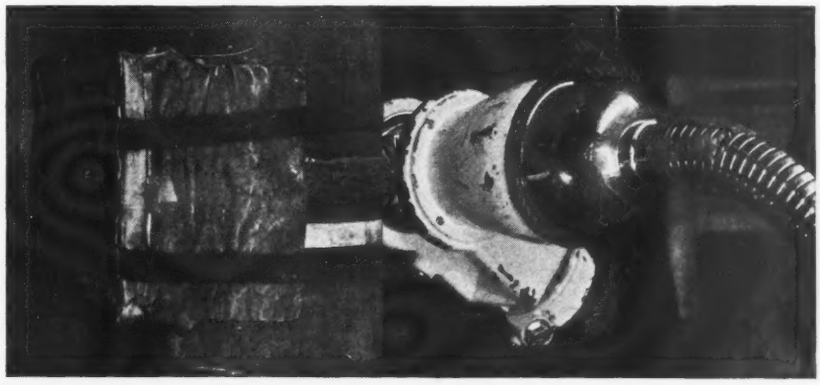
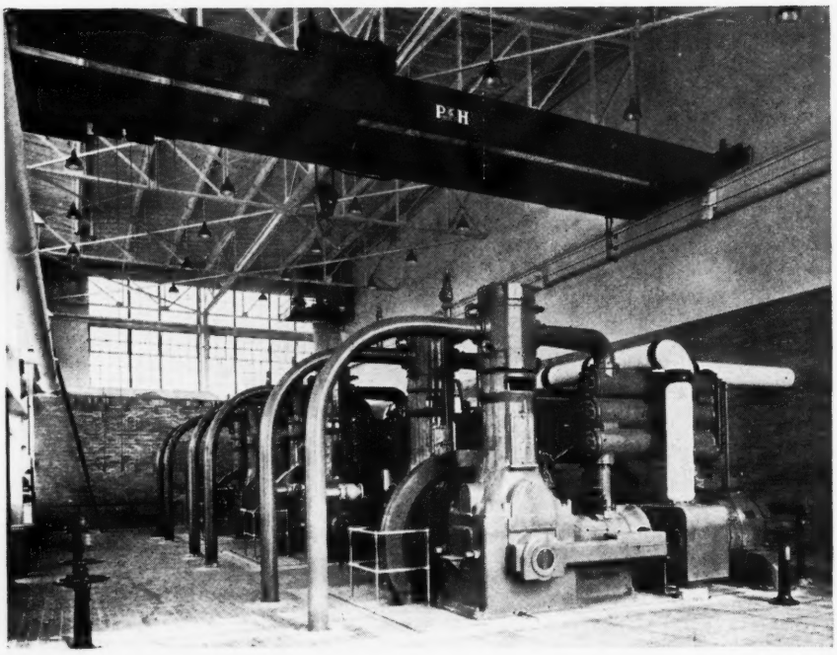


Fig. 11—X-ray tube in position with lead-shielded film holder strapped to pipe



Air compressors installed in a clean, well-lighted plant where they are under the supervision of trained operators. Overhead crane facilitates installation and repair of equipment

How to Maintain Air Compressors—II

By J. M. Bartholomew
Engineering Department,
Sullivan Machinery Co.

Maintaining the cooling water supply, care of valves, discharge piping, intercoolers aftercoolers, receivers, use of gages and upkeep of electrical equipment are discussed in this concluding section

IN THE August article, such features as proper installation, lubrication, use of air filters, care of compressor intake passages and discharge piping, were considered. This article carries the inspection and maintenance program through to include the entire installation.

Cooling water that carries sediment or scale-forming material will soon clog pipes and cylinder water-jacket spaces, causing high air temperatures. Scored cylinders and cracked cylinder-heads have resulted because an operator did not turn on the cooling water when the machine was started. Sight-flow indicators are in general use on cooling-water lines, and experienced operators note water flow before starting and water temperature each subsequent visit to the machine. To secure satisfactory intercooling on a 2-stage compressor adjust the quantity of cooling water to give a water-discharge temperature of around 100 to 120 F to insure cylinder liners being sufficiently warm to give proper distribution of oil on their surfaces.

Presence of air bubbles in the sight-flow indicator generally means leaking gaskets, or leaky intercooler tubes. Such leaks must be repaired, or damage to the machine will result.

General rules for maintenance of compressor valves will be similar, regardless of the type of valve. First, make sure that excessive dust or grit is not present in the air handled by the compressor to cause rapid valve wear. Valves damaged because of grit show characteristic signs. The surface of the material where it does not touch the seat or spring remains bright and clean. Edges which bear on valve seat or against valve spring or guard show excessive wear. Do not confuse these conditions with a somewhat similar condition caused by poor oil.

Valve Trouble

Excessive moisture and corrosive gases in the air are the next most common cause of valve trouble, a condition generally localized in the second stage of a 2-stage compressor. This is because the air, after passing through the first stage of compression and then being cooled, becomes saturated with water vapor. Corrosive gas, if present in the air, is absorbed by this water and increases its corrosive action. This moisture also tends to wash away lubricating oil from valves, pistons, and cylinder liners causing excessive friction and wear. Special oils have been developed that are not seriously affected by excessive moisture and may be used where corrosion and wear from humid air is a problem.

Oil that breaks down to form flinty carbon deposits at relatively low temperatures should not be used for air cylinders. Even soft carbon formations are objectionable and cause wear and valve breakage. Since the amount of oil as well as its quality influence carbon formation, use only the amount needed for proper lubrication. Defective discharge valves which allow air to leak back into the cylinder and be recompressed, defective unloading devices and similar elements operating incorrectly or inefficiently cause high air temperatures that contribute to breakdown of lubricating oil and carbon formation on valves. High temperature also affects valve life, and it is therefore necessary to make sure that any conditions causing high discharge-air temperature are corrected.

Maintain valve lift as it is for new valve assemblies; an increase in lift will reduce valve life. When seats are ground to clean worn or damaged surfaces, readjust valve lift by grinding off the guard an equal amount or by remachining the counterbore into

which the guard fits. Rough spots on valve seats or guards cause valve and spring breakage. For particularly severe conditions special valve and valve spring material may be required. Report conditions to the manufacturer's representative and request recommendations.

Mention has already been made in the previous article of safety valves or other protective devices used in the discharge line. This may well be repeated, since several serious accidents have been caused by starting up air compressors without first opening the valve to the receiver. Check safety valves occasionally to make sure they are properly set and in good operating condition.

The line from high-pressure discharge to receiver or aftercooler should be as short and straight as possible. It is poor economy to use pipe too small or with several right-angle turns, because they can easily cause 3 to 4% increase in power to drive the compressor. The receiver should be placed out of doors, in a reasonably cool or ventilated location. Gages should not be mounted on the pipe line from compressor discharge to the receiver. To avoid pulsations, mount the terminal gage directly on the receiver, or connect it to the receiver with a small pipe used solely for the gage. Do not use receivers that have not been designed for compressed-air service and do not allow them to become rusty or defective. Inspect the receiver and drain oil and water regularly.

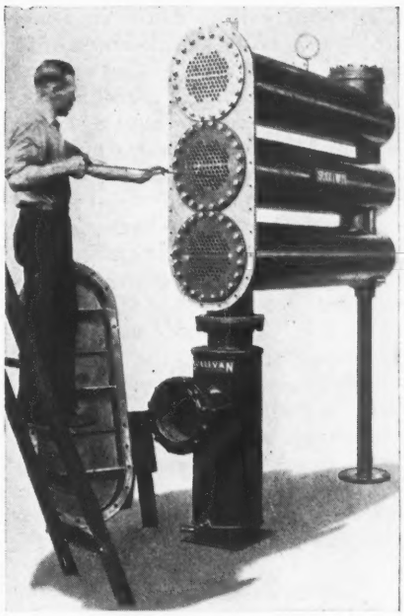
Aftercoolers require very little care other than seeing that an adequate supply of cooling water is provided and that they are cleaned and that the moisture traps drain at regular intervals.

Inspect pipe lines annually to make sure that joints are tight. Large power losses result from leaking air lines. These lines are often installed without much planning and are extended as demands for air arise in other locations. When these lines have been extended several times with more or less temporary piping or with air hose, rebuild the entire section with pipe of adequate size. Install moisture traps at low points on the air line to prevent an accumulation of dirt, water or oil sludge which will restrict air flow. Such traps insure clean, dry air.

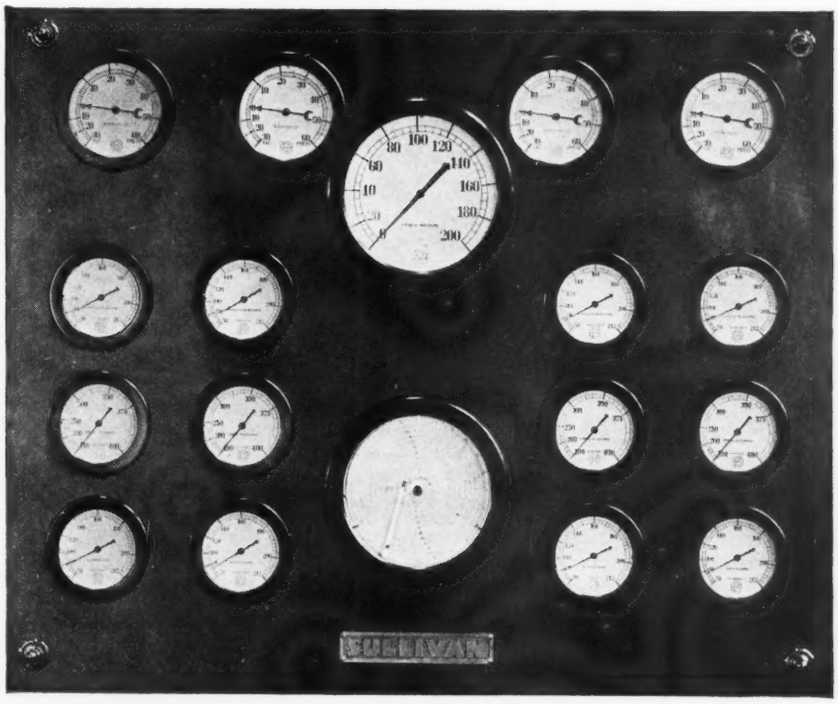
Gages are frequently left hanging on a pipe end extending down from the ceiling. Vibration shakes the gage, and moisture in the line causes a deposit of water that produces corrosion. Mount gages on a gage board and provide light so that their readings are visible at all times. Provide thermometers on this board to give the operator a convenient indication of air- and water-discharge temperatures.

Supply unloading equipment with clean, dry air from the receiver. A small moisture separator, and screen in this line will prevent trouble with pilot valves and unloading mechanisms.

Electrical devices have come into quite general use, particularly on large compressors because of the accuracy of pressure switches and dependability of magnetically operated valves. Magnetic valves for turning on cooling water insure that water will be turned on when the machine is started and turned off when it is stopped.



Water and air passages of intercoolers and aftercoolers should be cleaned regularly

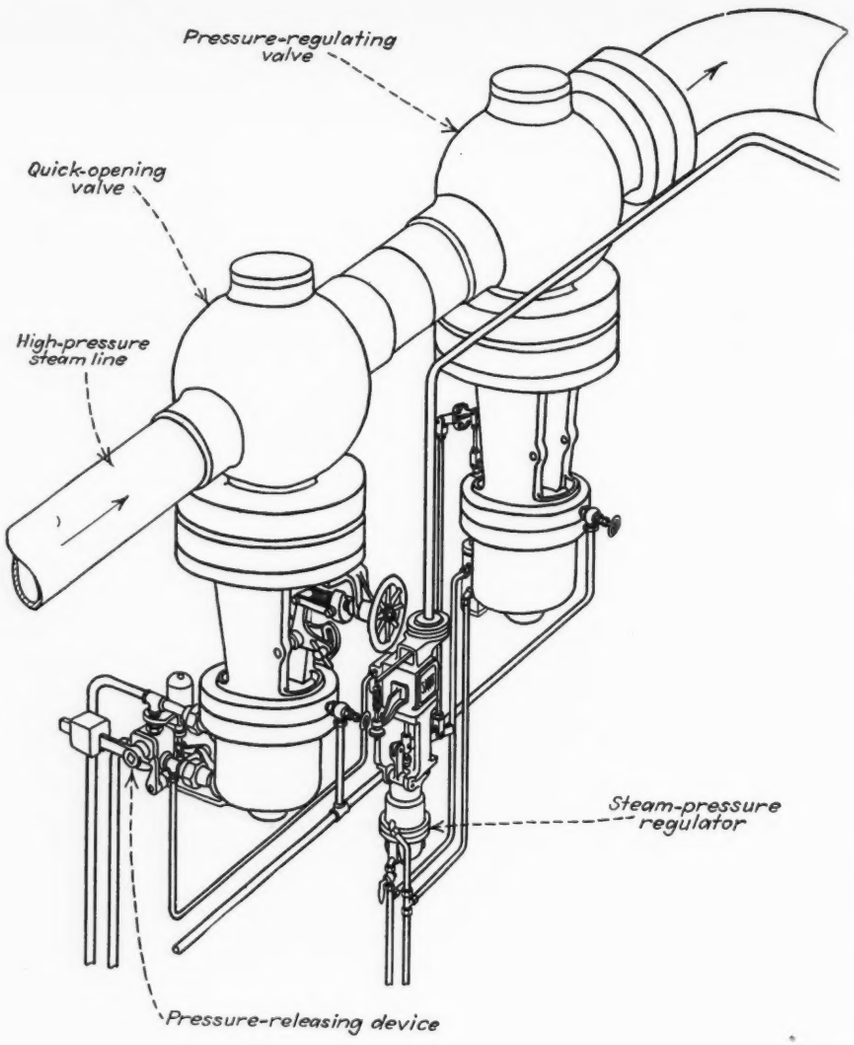


Pressure and temperature gages on a board like this are a good investment for they give the operators necessary information on compressor performance

Electrical Equipment

Maintain motors, motor-generator sets and control equipment in accordance with instructions provided with the equipment. Maintenance on these items is largely a matter of keeping them clean and renewing worn parts such as contact tips, motor brushes, etc. The regular use of a megohmmeter or other insulation-resistance measuring device will serve as a check on the condition of the insulation, and expensive breakdowns can be prevented by cleaning and drying out wiring that shows a low-resistance reading between line and ground. Insulating varnish may be used on old windings to improve their insulation or the apparatus can be sent to a service shop for inspection and reconditioning if insulation-resistance readings show a dangerous condition. These instructions apply particularly to electrical equipment which is being returned to service after a prolonged shut-down.

In this and the previous article an effort has been made to summarize briefly instructions which might be given the operating men by the plant engineer. It will be obvious that little new information is included, but since many of the points may otherwise be overlooked until trouble has developed, a review of such written instructions from time to time is of value.



West End Solves Its Bypass Problem

One quick-opening and one regulating valve, plus the world's largest desuperheater, bypass up to 1,050,000 lb. of steam per hr., reducing it from 1,200 lb., 900 F to 260 lb., 600 F at all loads

By A. F. Spitzglass

Vice-President, Republic Flow-Meters Co.

AT THE WEST END Station of Cincinnati Gas & Electric Co., a pressure reducing and desuperheating station has been installed that is capable of bypassing to the low-pressure system, at reduced pressure and temperature, the entire 1,050,000 lb. per hour of 1,200-lb. steam that flows through the superposed high-pressure turbo-generator. Considerations governing the design of this station both as a bypass and as a reducer of pressure and temperature are: need for high capacity and quick action, accurate regulation at all loads, and ability to sustain high pressure and temperature. Since these considerations are common to all superposition plants, the following discussion aims to bring out the fundamentals of the problem and details of the methods and equipment adopted for solving it.

Operating Conditions

In this superposition plant, designed by Sargent & Lundy, Inc., consulting engineers, of Chicago, three new 350,000-lb. per hr. B. & W. pulverized-coal-fired boilers make steam at 1,200 lb. per sq. in., 900 F. This steam passes through a Westinghouse 35,000-kw., 3,600-r.p.m. turbo-generator which exhausts at 260 lb., 600 F to the main steam headers of the existing station. Four of the 260-lb. boilers have been removed entirely, but several remain for standby use; consequently the high-pressure turbine exhaust now becomes a major source of steam supply to the low-pressure headers that feed steam to low-pressure turbines. The size of the high-pressure turbine has been selected so that its steam flow is sufficient to supply two low-pressure units of 36,000-kw. capacity each.

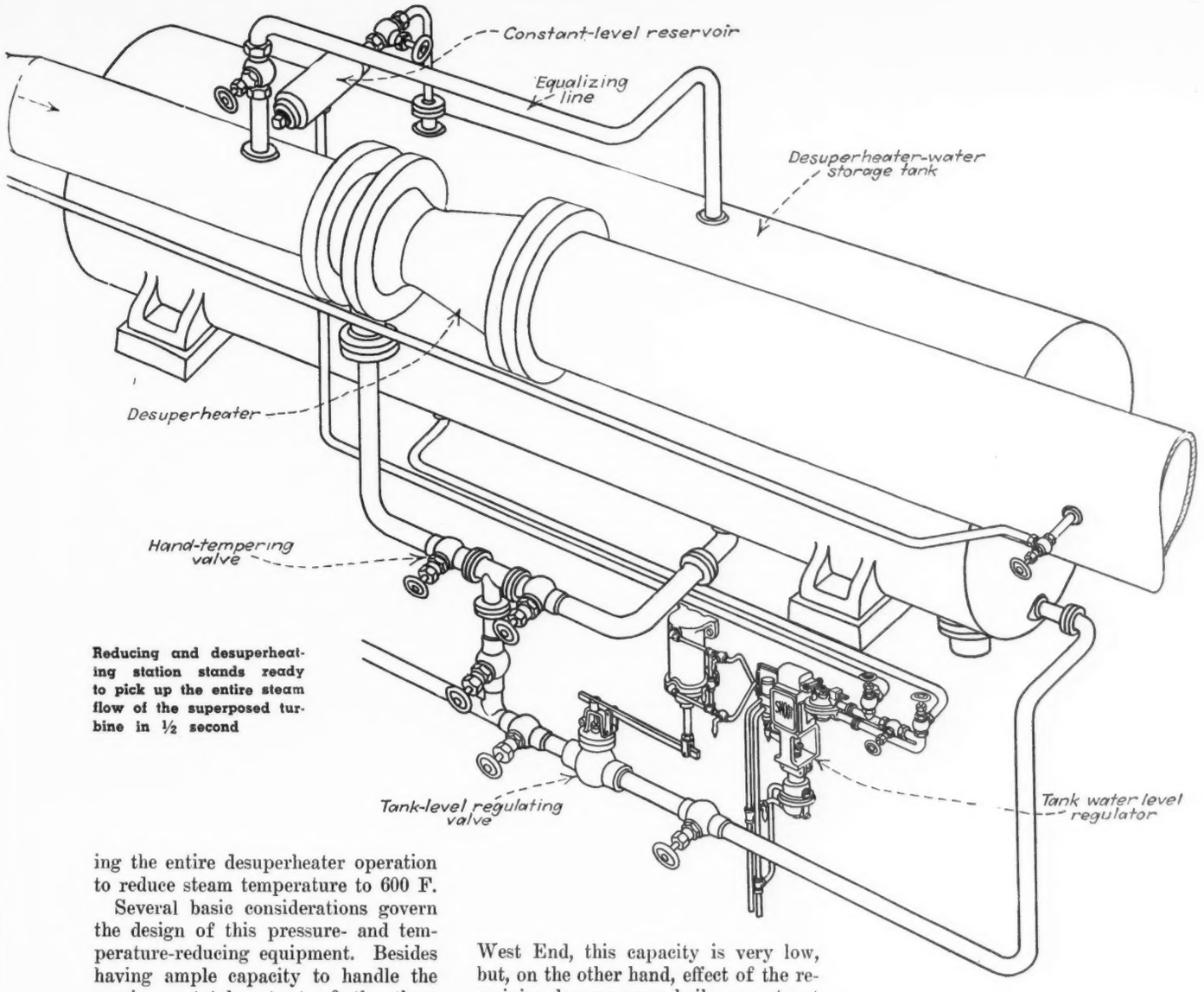
In operation, this coupling of the high- and low-pressure turbine units would ordinarily produce the effect of a cross-compound unit. If the turbines were operated in this manner, however, loss of the high-pressure turbine or its generator would immediately involve the low-pressure units and would necessitate the withdrawal of a very considerable amount of generating capacity. To prevent such a loss of capacity, a bypass around the high-pressure turbine is necessary to pass sufficient high-pressure steam for operating low-pressure turbines in case the high-pressure turbine trips out.

The high-pressure turbine itself acts basically as a reducing valve and is therefore controlled by a back-pressure governor to maintain desired pressure on the low-pressure headers. The bypass station is controlled by the same low-pressure header requirements. Thus two systems are available for supplying high-pressure steam to the low-pressure turbines; in one system power is generated, in the other it is not, but in each case desired pressures and temperatures are maintained on the low-pressure headers.

To meet the requirements outlined briefly above, the pressure reducing and desuperheater station consists essentially of these elements:

(1) Two Smoot turbine-type valves for control and pressure reduction; one valve, with solenoid operated trip mechanism, acts as a quick-opening valve; the other, under control of a Smoot regulator with certain special attachments, controls steam flow for any condition of high-pressure turbine load; the two valves, together with the desuperheater element itself, produce the required pressure reduction from 1,200 to 260 lb. per sq. in.

(2) A Smoot storage-type, spray-type desuperheater, equipped with the necessary water reservoir, standard Smoot water-level control system and other necessary accessories for govern-



Reducing and desuperheating station stands ready to pick up the entire steam flow of the superposed turbine in ½ second

ing the entire desuperheater operation to reduce steam temperature to 600 F.

Several basic considerations govern the design of this pressure- and temperature-reducing equipment. Besides having ample capacity to handle the maximum total output of the three new 1,200-lb. boilers, it must be capable of completely shutting off the bypass line when the high-pressure boilers are producing only the amount of steam passing through the high-pressure turbine.

Finally, in the event that the high-pressure turbine trips out, the governor valves on the turbine may close very fast, hence the bypass valves may have to go from closed position to wide-open position at corresponding speed. Of this speed, varying estimates have been made; the equipment has been designed on the basis of the most pessimistic estimate, which was ½ sec.

Stated in another way, the bypass station must be able to open its valves to a stable control position and feed sufficient water to cool the steam to the desired outlet temperature within ½ sec. of the time the impulse is felt. There is considerable debate over the necessity for such fast action and it may be that this requirement is much exaggerated. The deciding factor is the capacity of the headers in the low-pressure system. Unfortunately, at West End, this capacity is very low, but, on the other hand, effect of the remaining low-pressure boilers must not be neglected. Therefore, when the high-pressure turbine trips under full load, the requirement that the bypass function in ½ sec. may be modified somewhat if there is enough capacity in the low-pressure system to keep the pressure from dropping as fast as this.

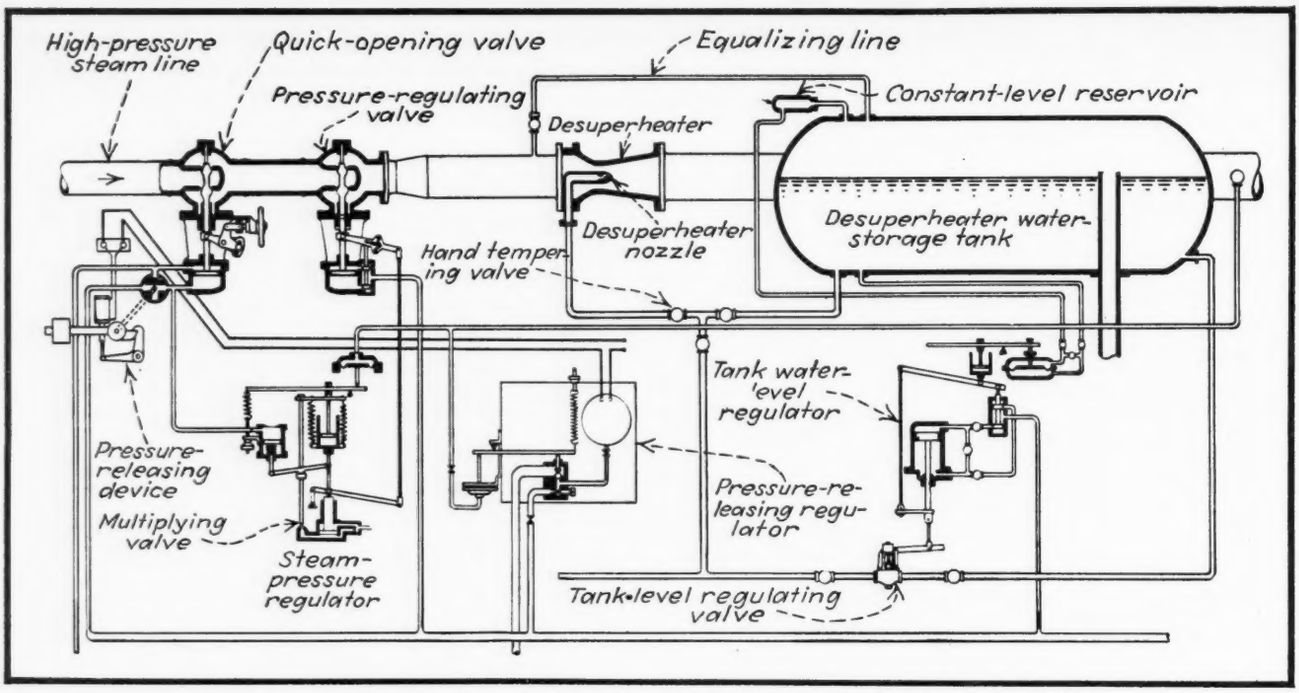
Another consideration that affects the bypass-speed requirement, however, is the low capacity of the high-pressure drums and headers. If bypass valves do not open fast enough, the high-pressure side will pop; this, in general is undesirable at high pressure and temperature. Best practice, even where an excess of steam is available, is to open the valves wide to the low-pressure side and pop on that side. The problem was solved by using two valves instead of one and by employing the quick-response characteristics of the storage-type desuperheater.

Two Valves Instead of One

Because of the high speed of operation required, we felt that it would be impracticable to operate a single regulating valve from a totally closed position to a stable, almost wide-open position, without having a tendency to hunt, in the short period of ½ sec. Therefore, instead of making one valve perform two duties—that is, both quick opening and regulating—two valves divide them, each responsible for only a single function.

The first is the shut-off valve which is controlled, as explained later, to move very quickly to its wide-open position under the emergency conditions mentioned above. The second, a regulating valve, floats at all times in the proper position to pass the quantity of steam flowing through the high-pressure turbine under the desired low-pressure conditions. As a result, when load is transferred to the regulating valve from the turbine, little motion is required of the valve. This is accomplished, in general, by relating position of the regulating valve to the load of the system so that the valve assumes a definite position corresponding to the existing load.

In addition to, and after reducing the pressure, it is necessary to cool the



Normal operation: Quick-opening valve is closed. With no steam passing through pressure regulating valve, it is always in the correct position for the load which might be going through it

steam by spraying water into it in a desuperheater. Because of the possibility of sudden demand for water, the desuperheater equipment is designed so that water in the reservoir can flow to the spray nozzle in the venturi without any parts, valves or controls having to move. This is of the utmost importance because feedwater controls of the temperature type would not start moving until after the rise in temperature in the low-pressure header is detected; consequently, before such regulators and valves reached their proper position, sufficient 900-F steam might flow to damage low-pressure turbines or fittings.

How the Equipment Works

If the high-pressure turbine is carrying load, the quick-opening valve is closed, the pressure-regulating valve is in a regulating position corresponding to the turbine load and no water is flowing from the desuperheater storage tank to the spray nozzle. Now, if the turbine trips out, a solenoid actuates the pressure-releasing device on the quick-opening valve and allows it to fly open. Steam then passes through it and through the regulating valve. Its pressure is reduced in these two valves from 1,200 to about 400 lb., but its temperature is still at 900 F. As soon as steam reaches the desuperheater nozzle, which produces a pressure drop, water flows through the spray nozzle and cools the steam to 600 F; also the steam pressure is reduced to the final value of 260 lb. required for the low-pressure system.

The quick-opening valve is held closed by an oil pressure of 100 lb. per sq. in. on the under side of the operating piston, the upper side of the piston being normally open to the drain. To control this piston, a 3-way valve is operated by an electrically-operated latching mechanism of very rugged design so that when the valve is to be tripped, a solenoid merely releases the latch and a weight moves the valve 90 deg. This movement shuts off the high-pressure oil that is holding the valve closed and puts a large bypass connection around the two sides of the power piston. The quick-opening valve itself is made with considerably more unbalance than the normal regulating valve and this unbalance of pressure, in addition to the end thrust on the stem, allows the steam at 1,200-lb. pressure to force the valve open. This is a tremendous force at the high pressure existing in these lines and the operating power piston now acts as a dashpot to control the speed at which this valve will open. Oil on the underside of the piston must replace oil above the piston through a bypass, as in an ordinary dashpot. By controlling size of this bypass, speed of operation can be controlled.

Theoretically, it is possible to open this valve to a wide-open position in considerably less than $\frac{1}{4}$ sec. A guarantee of $\frac{1}{2}$ sec. has been made, but this time can be regulated to any time desired because the bypass can be adjusted to suit conditions.

The latching-mechanism solenoid may be operated by a series of contactors in parallel with each other, one of which is placed at the turbine exhaust, another on the overload trip. As many contactors can be used as considerations of safety may dictate. For the time being, the only contactor installed is the one on the low-pressure side of the turbine. A hand wheel is supplied on this quick-opening valve for starting up.

Multi-Position Valve

The regulating valve is controlled by the pressure at a point in the low-pressure system beyond the desuperheater. This pressure is measured and balanced against a calibrated spring, set for constant pressure, plus a set of fixed-characteristic springs, which change the loading of the regulator so that, for every valve position, it controls for a slightly different pressure on the low-pressure system. The same thing is done on the back-pressure governor of the high-pressure turbine.

By pressure adjustment of the fixed-characteristic springs, both the turbine back-pressure governor and the reducing valve are made to have the same characteristics of position against pressure or capacity against pressure. Therefore, assuming that there is no steam going through the reducing valve, the regulator controlling the reducing valve is made to assume a position corresponding to that of the high-pressure turbine throttle valve or the main load, because the turbine will be delivering steam at a low pressure that corresponds with only one setting of the springs on the regulator. Consequently, if high-pressure steam flowing through the turbine is shifted to the bypass, the regulating valve would be in the proper position to pass it.

In addition, a device on the regula-

tor prevents the regulating valve from closing all the way when there is no steam going through it. This is to prevent total closure of the valve at a time when the high-pressure turbine may be on speed control. At such a time, the turbine may be carrying a high load and at the same time the operators of the low-pressure boilers may be maintaining the pressure rather high on the low-pressure system. As a result of this low-pressure condition, the regulating valve would have a tendency to close. But since the high-pressure turbine, whenever it is on the line, will not be passing less than 250,000 lb. of steam an hr., this stop prevents the valve from closing below this point.

This limiting device operates as follows: a special plunger in a cylinder, held down against a spring by the high-pressure oil that holds the quick-opening valve closed, is connected with an arm to the regulator so that the arm bears on a lug on the amplifier-valve stem and prevents the regulator from closing below 25%. When oil pressure is released to trip the quick-opening valve, the spring pushes the plunger up, moves the arm away from the lug and allows the regulator to operate throughout its full range.

Desuperheater-Water Control

Desuperheater equipment consists of a venturi containing a spray nozzle connected to a water reservoir in which the level is controlled by a standard water-level controller. This equipment operates on the simple principle that steam flow through the venturi creates the pressure drop that makes water flow to the spray nozzle, which sprays it into the steam. The supply line to this nozzle is open at all times and no valves have to move to supply water to it. The only control equipment is that which maintains constant level in the reservoir.

In operation, water from the feedwater makeup is fed into the reservoir in which the water level is maintained at the center line of the spray nozzle. An equalizing line transmits to the top of the reservoir whatever pressure exists in the bypass line just ahead of the desuperheater venturi. If there is no pressure differential between the steam space above the water and the nozzle, no water will flow. As soon as steam flows through the desuperheater towards the low-pressure side, however, the venturi creates at its throat a drop in pressure proportional to the square of the velocity. This lowered pressure is also the exit pressure at the spray nozzle. Therefore, the pressure differential between the water in the top of the tank and the point of the nozzle changes and is exactly the same as the differential due to the steam drop. This pressure, about 150 lb. at maximum steam flow, makes water flow from the tank to the spray nozzle.

The hand-tempering valve, in effect an orifice of variable area, is adjusted and set so that the amount of water for a given pressure differential will be exactly that required to drop the heat content of the steam to the desired amount. This hand-tempering valve can be set in many ways; the simplest method, of course, is merely to obtain some constant condition and set it so that the desired pressure and temperature will result beyond the desuperheater.

Water Jets

An important design element is the placing of the water jets at the very center of the desuperheater throat, where the highest velocities exist, so that the water sprayed at high velocity is immediately sheared off and carried in suspension down stream.

In this installation, maximum steam flow of 1,050,000 lb. per hr. will absorb 135,000 lb. of water an hour. A storage tank 3 ft. in diameter and 32 ft. long, with a capacity of 1700 gal., supplies this water. The water-level control keeps this tank over half full, thus making available about 900 gal., which will operate the desuperheater for 3 minutes at maximum load. The tank was designed for 450 lb. pressure, to which it is subjected by the equalizing line.

Because of the pressure and temperature conditions, and large size of the valves in this installation, materials used throughout were given the closest attention. The bodies of the quick-opening and regulating valves are carbon-molybdenum steel and weigh over 2 tons each. In view of their complicated coring and large size, complete X-ray analysis was made of both bodies. Both valves are designed to the A.S.A. 1,500-lb. standard; the quick-opening valve has a 10-in. inlet, 12-in. outlet, the regulating valve 12-in. inlet and 14-in outlet.

Stems for these valves are solid drop forgings, 12% chrome steel, each made entirely of one piece 7 ft. long, hardened and ground all over. High-pressure sides of the valves were welded into the pipe section in place. Because of the excessive thickness, 29 beads were required. Valves were stress annealed and the usual provisions made for annealing rings and for stress relieving after valves were in place. The welding and annealing do not affect the alignment of the valves in any way.

The desuperheater nozzle and venturi were also made of carbon molybdenum steel because the high temperature exists to the outlet of the desuperheater even though the pressure is lower. This is believed to be the largest reducing valve and/or desuperessentially the same as at West End Station.

A similar installation, for a slightly lower capacity of 700,000 lb. per hr., is now being made in the new superposition plant at Fisk Street Station of Commonwealth Edison Co. in Chicago. Here the 25,000-kw. superposed turbine takes steam at 1,200 lb., 925 F, and exhausts at 220 lb., 540 F to the low-pressure system. Operating requirements for the pressure-reducing and desuperheating station and for bypassing the high-pressure turbine are essentially the same as at West End Station.

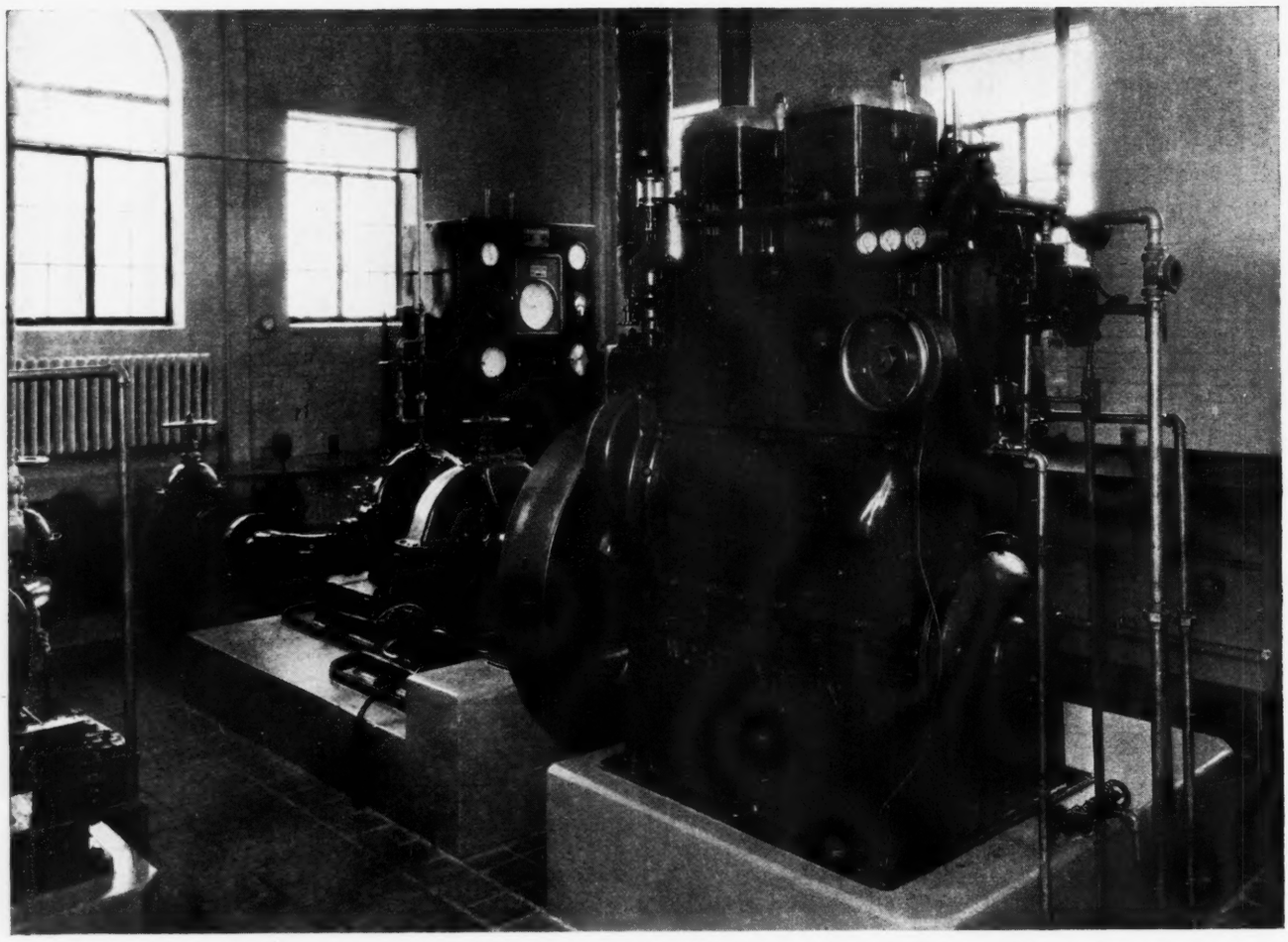
At West End Station, in addition to the pressure-reducing and desuperheating station described above, the three new 1,200-lb. boilers are equipped with a complete automatic combustion-control system that regulates pulverized-coal feed, induced draft fan dampers and forced-draft fan inlet vanes, the latter to control furnace pressure. Feedwater-level controllers and excess-pressure pump controls govern feedwater level and pressure. All this equipment was supplied by Republic Flow Meters Co., Chicago, Ill.

A Close Call

ONE MORNING, a boiler-plant door opened, and in walked the boiler inspector. As he and the engineer casually walked into the boiler room, the inspector asked, "Just give your safety-valve levers a pull, Jack, then we'll check over the water columns and blowdowns." As the engineer started up towards the safety valves, the inspector cast an eye at the gage glasses. Water level was nowhere in sight in any of six glasses.

"Mr. Inspector," followed by Jack, immediately went over and tried several try-cocks. Water showed from some; steam from others. Then, he tried the water-column blowdown valves. While vibration showed the line to be free, there was no visible action in the glass. After noting these indications, a ladder was thrown up and "Mr. Inspector" climbed to the level of the gage glasses. Imagine his astonishment, and the dismay of the engineer and fireman when all six gage-glass shutoff valves were found closed. It was then 10:00 a.m. and the boilers had been operating with closed water glasses since six o'clock that morning.

On opening the gage-glass valves, water level was seen to be high—out of sight in three boilers, and dangerously low in two. Needless to say a "little lecture" was in order, and it was promptly delivered to all concerned.



The 60-hp. diesel drives a 500-g.p.m. centrifugal pump through a speed increaser. The switchboard is in center background

Gasoline Supplements Diesel

By Paul F. Howard

Consulting Engineer,
Whitman & Howard, Inc.

As told to Francis A. Westbrook

A PUMPING station and water system installed during the past year in Cotuit Fire District, Barnstable, Mass., on Cape Cod, is unusual in its combination of a main diesel unit with gasoline-engine-driven standby, the high efficiency of the diesel giving good station economy while the low first cost of the gasoline engine provides low capital-cost emergency service.

The diesel and the gasoline engine each drive a 500-g.p.m. centrifugal pump at 1,800 r.p.m., the gasoline engine (because of its higher speed) driving direct through a flexible coupling and the diesel through a 1-3 speed increaser. Auxiliaries are also in duplicate to provide for almost any contingency. Thus there are two vacuum-pumping units, one gasoline-engine driven, one motor driven, and two diesel-starting-air compressors similarly powered. Discharge head is 217 ft., and suction lift 10 ft., giving a total dynamic head of 227 ft. Shut-off pressure is 275 ft.

Water Source

Water is obtained from four gravel-packed wells of the low-velocity type, 52 in. in diameter and 30 ft. deep. It is pumped to an elevated 200,000-gal. tank, from which it is distributed through 8 miles of water mains.

The diesel is an 8x10½-in., 2-cyl., 4 cycle, 60-hp. Worthington unit operating at 600 r.p.m. It is connected through a Falk herringbone speed increaser and a Morse chain-link flexible coupling to the 500-g.p.m. Pennsylvania centrifugal pump. Safety devices include both overload and overheat protection. All engine, gear and pump bearings have thermostatic relays which operate a solenoid valve to shut off fuel supply to the engine if a bearing becomes overheated. There is also an altitude valve at the bottom of the water tank which shuts off slowly as the tank becomes full. Then the pump, working in a closed system, builds pressure up to 275 ft., at which a pressure switch closes and cuts off fuel supply to the engine.

Fuel is stored in a 2,000-gal. underground tank from which it is normally drawn directly to the engine, although there is a 50-gal. emergency tank on the engine-room wall to which oil can

be pumped either with a motor-driven unit or by hand. Cooling water for both diesel and gasoline engine is provided from the high-pressure side of the water-distribution system, being returned to the suction side of the pumps. This provides a closed circulating system that wastes no water and requires no pumps.

Diesel starting air at 225 lb. is provided by two 2-stage, air-cooled, 5-c.f.m. compressors, one driven by a 3-hp. Ideal motor, the other by a 5-hp. Lawson gasoline engine. Two air tanks in the attic of the station are equipped with automatic controls which operate the motor-driven compressor to maintain pressure. There are also two Nash vacuum pumps, similarly driven. The sand catcher and priming tank have two float switches, one a low-level control on the electrically driven vacuum pump, the other operating the solenoid valve on the diesel fuel-supply line. In case of a priming failure, the latter shuts down the engine before the pump is burned out. The tank itself is insulated against sweating with three coats of ground cork on wet paint.

The 6-cyl. 67-hp. Buda gasoline engine driving the emergency pump is started by a battery, which in turn is kept charged continuously. The unit may also be used in case of excessive demand for water, as in case of fire.

The entire engine-room foundation is one slab of concrete 4½ ft. thick. Pedestals have been brought up through the floor for each piece of equipment. This arrangement, plus a 13-ft. by 10-in. Maxim silencer, avoids almost all noise and vibration. The silencer is in the attic and exhausts at one end of the building. The gasoline engines have ordinary mufflers mounted on the rear wall of the building.

Cotuit has a diesel-driven pump for economy, a gasoline unit for low standby cost

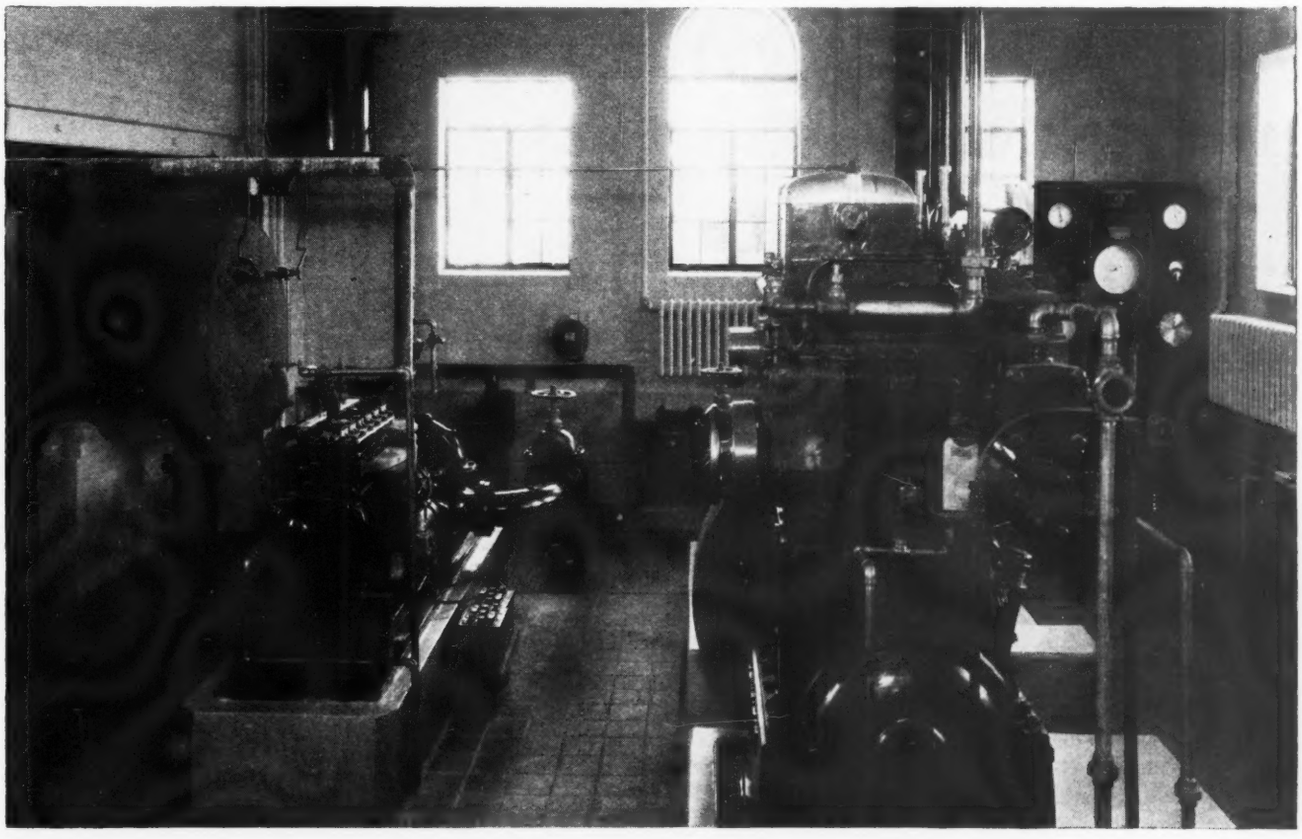
As Cotuit is decidedly a summer place, the diesel will operate only intermittently in winter, and possibly on on-and-off service at various times even during the summer. This can be done readily with a diesel without loss of efficiency. An idea of unit efficiency may be gained from the fact that from Feb. 17 to May 17, a total of 1,162,200 gal. of water were pumped with 126.8 gal. of fuel in 40.75 operating hours. After a crankcase oil change April 7, the engine used 2 qt. of oil up to May 17. No longer operating record is available because the system is being built up gradually, and design capacity may not be reached for a year or two.

DIESEL CORRECTION

IN THE list of diesel manufacturers and suppliers, page 377, June *Power*, data for Worthington Pump & Machinery Corp. was incorrectly listed. They should have been:

Type	No. Cyls.	Hp/Cyl.	R.p.m.
B	2,3,4,5,6	25	514
BB	2,3,4,5,6	30	600
C	3,4,5,6	50	400
D	3,4,5,6	75	327
EE	3,4,5,6,7,8	125	327

Another view of the engine room, showing the gasoline-engine driven emergency pump at left, with the insulated priming tank behind it and the emergency fuel tank for the diesel above



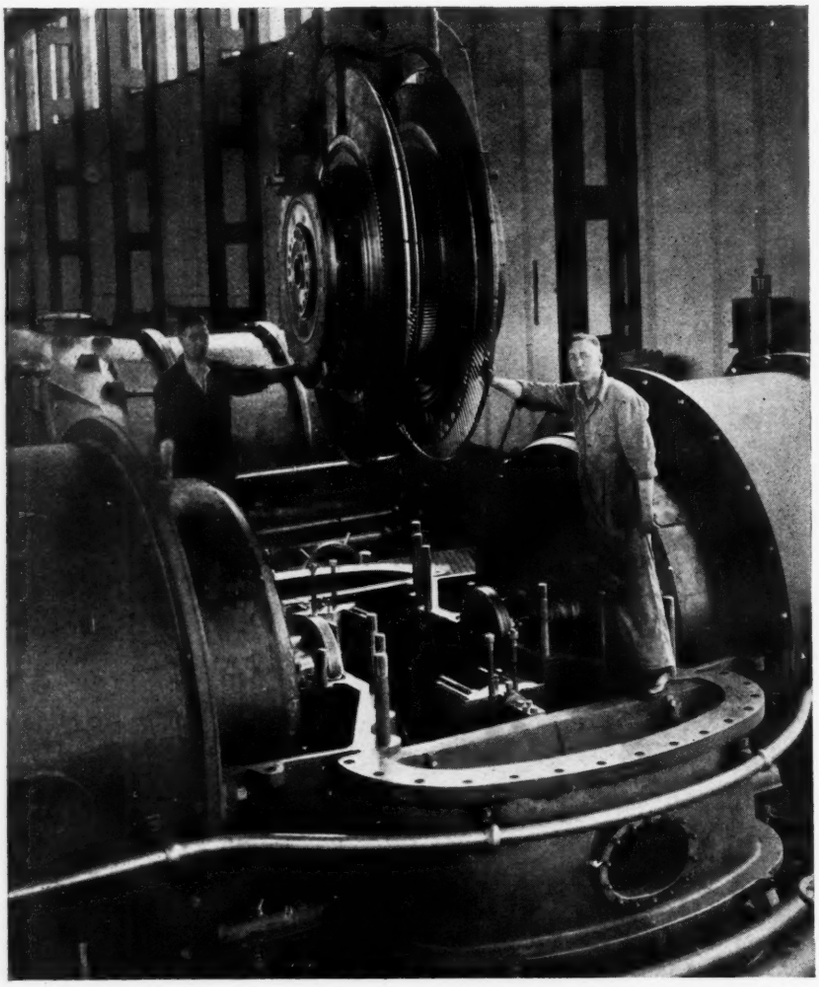


Fig. 1—Lifting inner turbine for inspection

The Radial—
Stepchild of American Turbines

Long-tested and not found wanting, the radial-flow double rotation turbine is universally respected in Europe. America will have none of it. "Why?" asks Mr. Savage. Answers are invited

By Harlow D. Savage
Vice President, Baker & Spencer, Inc.

WHILE axial-flow steam turbines have been brought to a high degree of perfection, the radial-flow turbine has been completely neglected in America. Thousands of radial double-rotation turbines (D.R. turbines) are operating throughout the world except in the United States. Why?

In past years, *Power* articles have listed the outstanding advantages of the foremost radial D.R. turbines, built in Sweden. The question they raised in one's mind is still unanswered: "Is not this the ideal turbine design for most generating purposes?"

The essential features of the radial D.R. turbine are shown diagrammatically in Fig. 2. Steam flows radially outward through the blades, which are fixed in concentric rings alternately to two wheels rotating in opposite directions. Stationary guide blades are eliminated. Generators of half the total output each are mounted on the shafts of the blade wheels and are electrically connected, their synchronizing forces serving to maintain uniform electrical frequency, as well as exactly the same speed of the two blade systems.

This type of turbine, then, apparently excludes other than generating purposes and, even in this field, permits the generation of d.c. only in combination with a.c. and at not more than 30% of the total generating capacity. The inherently small dimensions make sizes below 600 kw. impractical. The axial-flow turbine therefore has no competition below 600 kw. or for other than a.c. generation. For a worthwhile comparison within the contested lines, however, let us consider axial- and radial-flow turbines from two viewpoints, first from the designer's, then from the user's view:

The Designer's Angle

The relative velocity of the two blade wheels in a D.R. turbine is twice that of either wheel. Therefore, under otherwise equal conditions, a radial D.R. turbine can utilize as much energy as an axial turbine with four times the number of stages. Conversely, smaller diameters of the stages may be used for the same heat drop. Essential to high steam economy are a high specific speed and a large exhaust area, which in large axial turbines has led to dividing the steam flow within the unit or to dividing the turbine into several units to provide sufficient discharge area at high specific velocity. Unfavorable flow conditions and complicated construction have resulted.

In the larger D.R. turbines combining double axial exhaust stages with the usual radial ones (Ljungstroem-Wilberg principle, Fig. 3), while the construction of the blade system appears rather complicated, the general layout is extremely simple and the flow conditions very favorable.

In the D.R. turbine, heat-distortion difficulties are less pronounced. The two shafts are so short that little distortion is possible. The housing is uniformly exposed to exhaust steam,

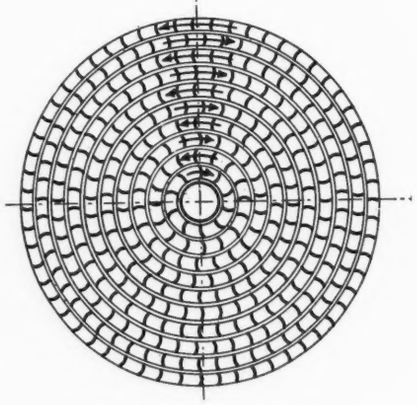


Fig. 2—Radial-flow turbine

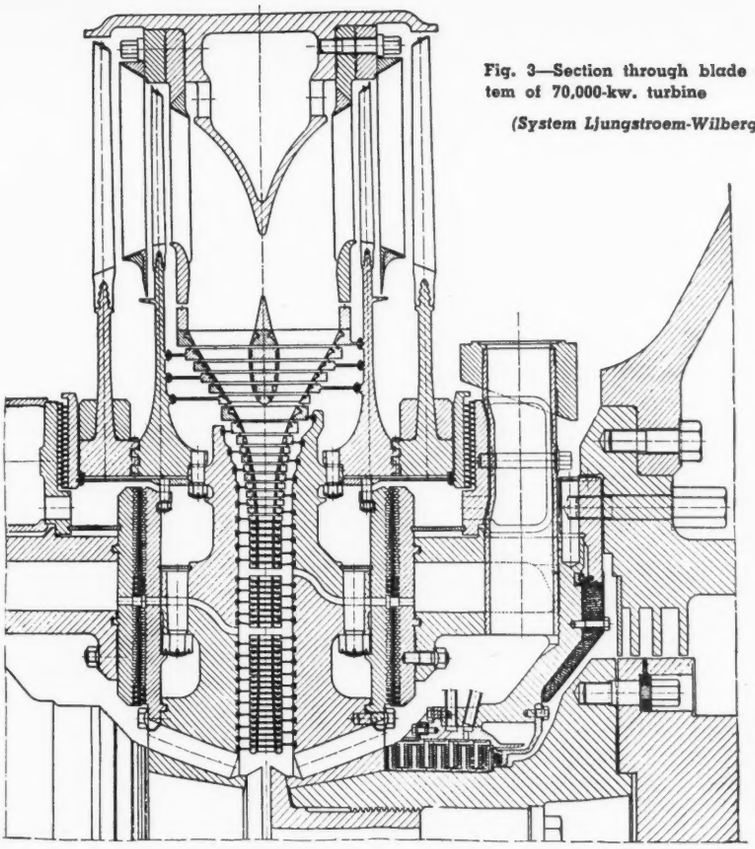


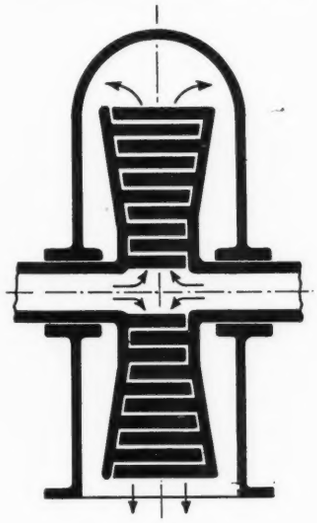
Fig. 3—Section through blade system of 70,000-kw. turbine

(System Ljungstroem-Wilberg)

while the extreme temperatures occur only in the central relatively small areas of the turbine. Therefore, special attention is necessary for design and construction of the blade systems only.

Low Stresses

The combination of high thermal and high mechanical stresses in the high-pressure part has been quite a problem to the designer of an axial turbine. In the D.R. radial turbine, areas exposed to high temperatures and pressures are subject to only fractions of the mechanical maximum stresses, due to the small radii at which they rotate. Fortunately, also, the performance of the D.R. turbine is based on the high relative velocity of the double rotation principle, while the mechanical stresses correspond to the absolute wheel velocity of only half the magnitude.



In the matter of leakage, the D.R. turbine, due to the relatively small radii of the high pressure areas, has a distinct advantage.

Contrary to requirements in the axial turbine, radiation or the prevention of radiation losses does not enter the design of the D.R. turbine at all, as the temperatures drop gradually from the highest in the center to the low exhaust temperatures to which the housing is evenly exposed.

The User's Viewpoint

Now let us take the user's standpoint: The previously mentioned factors produce a steam economy at all loads in the D.R. turbine, which has not been equalled by any axial turbine. The record of a thermodynamic efficiency of 90.3% is held by a D.R. turbine.

The D.R. turbine is much smaller and more compact than an axial turbine, requiring, therefore, smaller buildings and smaller foundations. Thus turbine, foundations and building should cost less.

While the starting and stopping of axial turbines often require hours and special precautions, especially in the larger types, it is claimed that a 50,000-kw. D.R. unit is started and synchronized by one man within 5 minutes, which makes this turbine an ideal industrial unit, and an ideal standby unit in generating stations.

Why Not Use Them?

Why is it, then, that we hear practically nothing of radial double-rotation turbines in America? Are they unreliable? Are they restricted in the use of high pressure, high-temperature steam? Are they short-lived?

Thousands of double-rotation radial turbines have been running successfully throughout the world, some of them for more than 20 years; they have operated with a minimum of attention and repair, as published service records show. A 50,000-kw. unit has been in operation since 1932, and designs for 100,000-kw. and more capacity are said to be completed. Turbines operating with throttle conditions up to 900 lb. and 1,000 F are in actual service.

All doubts are apparently met by satisfactory answers, leaving the first question alone still open. It demands serious attention and challenges those concerned not to neglect any longer what has been developed to a high degree of perfection in other countries.

Keep Foundations Free from Oil and Water

A PEDESTIAL BEARING of a 4-cyl., vertical steam engine required an unusual amount of oil, and shortly after this condition was noticed, considerable movement of the corresponding bedplate took place. A crack, $\frac{1}{4}$-in. open on one side and $\frac{1}{8}$-in. at the other, was found below the bearing, extending across the arm of the bedplate. Farther along the arm, underneath a column, a second crack, $\frac{1}{8}$-in. wide, had developed. The bedplate for each pair of cylinders was of the box type, and lay transverse to the crankshaft, the entablature columns being bolted on at each end.

The bedplate naturally had to be replaced. Failures of this kind, with resulting engine shutdown, can be avoided if care is taken to keep foundations of large engines free from oil and water. Metal flashing should be removed periodically to see that no deterioration of foundation surface is taking place, and that no movement of the bedplate on the foundation is occurring. Also, a periodic check should be made on the level of large bedplates.—Abstracted from the *Technical Report for 1935 of the Royal Insurance Co., Ltd.*

Variable-Speed Motors Solve Pumping Problems

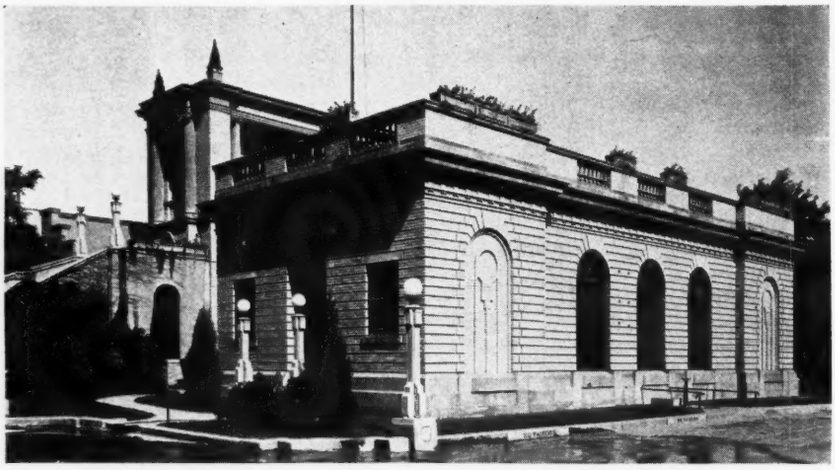
The City of Omaha, Neb., modernized its water-supply system by installing slip-ring, induction-motor-driven, centrifugal pumps, the speed of which is adjusted to obtain required capacity and head

By Chas. F. Holdredge
Metropolitan Utilities District, Omaha, Neb.

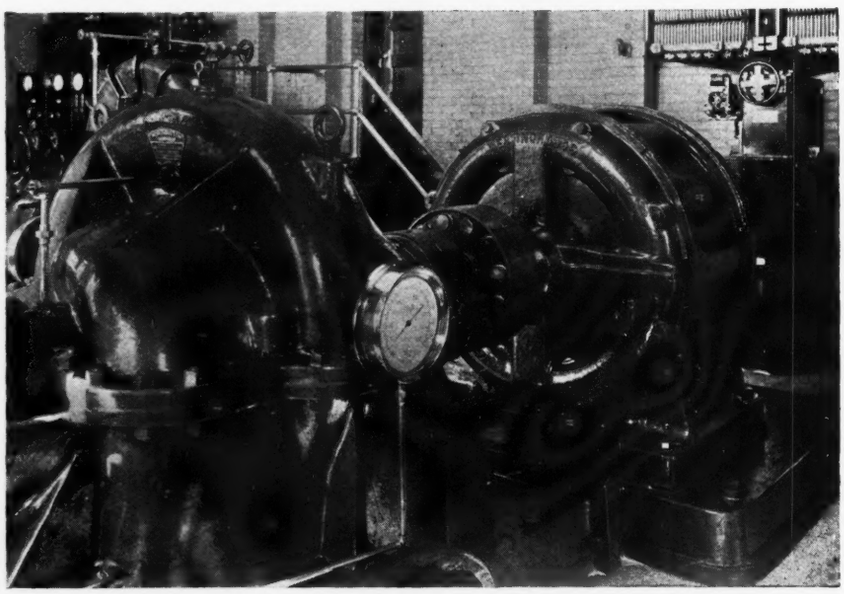
and E. L. Bebb
Industrial Division, Westinghouse Electric & Mfg. Co.

COMMON with the rest of the Middle West, Omaha, Neb., has experienced a prolonged period of abnormally dry and hot summers, with consequent heavy demands on its water system. Because of experiences during the past few summers and gradually increasing use of water during all seasons, the city's water department has increased its pumping facilities. All water is pumped twice, and about 60% of it is handled a third time by booster pumps. A survey of water requirements resulted in an increase in facilities in each of three stages.

A first step toward enlarging the pumping capacity was made in the area supplied by booster equipment. This high-pressure area is fed from three stations, of which only two, and sometimes one, are normally in operation. As this area has no storage, a wide range of pumping rate is necessary. The maximum rate of water that could be delivered into this area and still keep satisfactory pressure at the high points was about 56,000,000 g.p.d. before the expansion program was started. During the summer of 1934 a maximum hourly demand reached approximately 96,000,000 g.p.d. This caused a rather short but severe drop in pressure in a few of the higher locations, just at the time when everyone was trying to reach that little spot of grass located about 50 ft. in front of the end of his 25-ft. hose. Of course, the answer was either elevated storage or more pumps.



Walnut Hill booster pumping station of the City of Omaha, where a new 8,000,000-g.p.d. pump driven by a 500-hp. variable motor has been installed

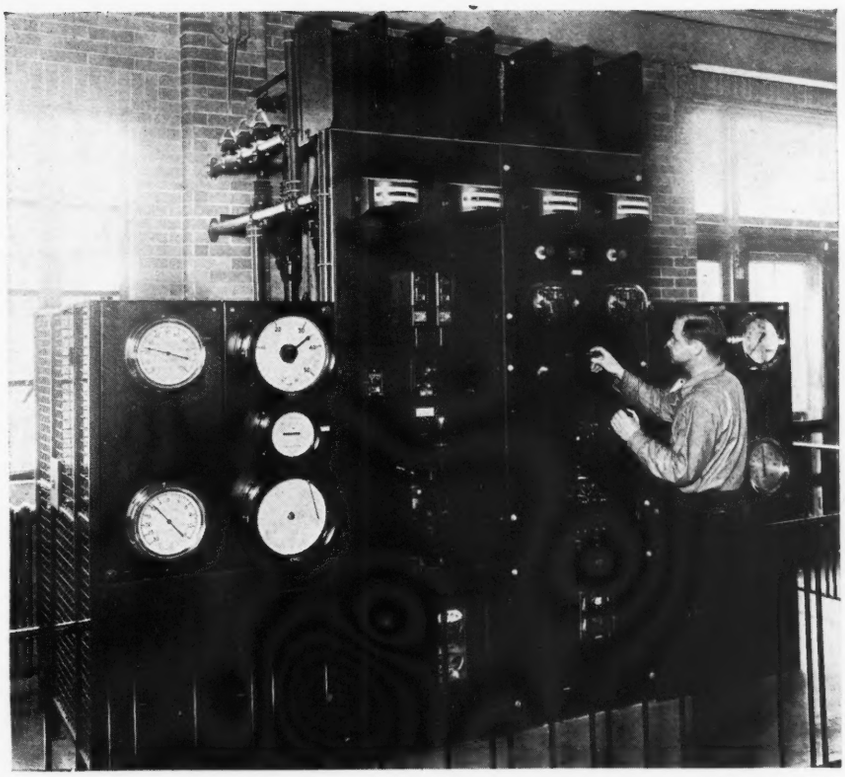


This new variable-speed-motor-driven booster pump has a speed range that permits it to follow the station head desired for a capacity range of 10,000,000 to 18,000,000 g.p.d.

Pumpage Range

This problem was solved with a new pump replacing a much smaller one. The pump selected was designed for 18,000,000 g.p.d. at 138-ft. head, and was installed in the station having the greatest pressure drop during peak periods. The head at rating point of the new pump is slightly higher than the old pump left in the station. About three-quarters capacity of the old pump and full capacity of the new pump can be realized at a higher head than the old station could maintain at full capacity. Pumpage range on this repumped system is extremely large.

In order that this new pump could be used as standby for existing equipment as well as give a smooth range of capacity above that of the existing pump when paralleled with it, a variable-speed drive was selected. It is not expected, however, to operate at reduced speed for any great period. A 500-hp. variable-speed slip-ring induction motor drives the unit, manually started and speed controlled from a pushbutton station operating a motor-driven drum controller. Speed variation steps were so selected that the pump will follow fairly closely the station head desired for a range of from



Control for the motor-driven 30,000,000-and 35,000,000-g.p.d. low-service pumps, speed of which can be adjusted by pushbuttons on these panels

10,000,000 to 18,000,000 g.p.d. This unit was completed last year. Tests show an over-all efficiency of nearly 84% at full capacity and a speed reduction of approximately 8% at the 10,000,000-g.p.d. rate and desired head.

Reservoir

At the main pumping station, water is pumped from the river to the settling basins and treatment plant by low-service pumps and then pumped to the city by high-service pumps. A storage reservoir of approximately 20,000,000 gal. floats on the high-service pump discharge. While this reservoir smoothes out hourly demand fluctuations to a great extent, there is still a daily variation in pumpage of over 300% during different seasons.

Until the fall of 1932, this plant was steam operated. At that time, two motor-driven, 35,000,000-g.p.d. pumps were installed, one on the low and one on the high service. These pumps both have variable-speed drives and have been used almost constantly since that time. Daily pumpage varies from 18,000,000 to 58,000,000 gal. during the year. During summer months, steam-driven equipment supplements the motor-driven pumps. Also in winter periods of low pumpage, the motor-driven pumps have been operating at reduced speeds that caused rather poor efficiencies.

The steam-driven equipment, while still in satisfactory operating condition, is not dependable for constant use, but is good for emergency service. Consequently, to take advantage of very favorable power rates, to eliminate steam equipment for daily use, to improve yearly efficiency of the motor-driven equipment, and to increase the maximum capacity of the station it was decided to install a motor-driven unit of lower capacity and head than the electric units in operation on both high- and low-service duty.

High and Low Service

The first of these, the low-service unit, a 600-hp., variable-speed, slip-ring motor driving a 30,000,000-g.p.d., 90-ft.-head pump, has recently been completed. Because of variations in river elevation, total head on this pump will range from 75 to 95 ft. On the high-service, a new 30,000,000-g.p.d., 235-ft. head pump is driven by a 1,500-hp., variable-speed, induction motor. Combined output of the two pumps on each service should be approximately 55,000,000 g.p.d. at required head for this station at pumpage rate. Pumpage range for the entire year should be covered by the two sets of pumps within a reasonable speed variation of each pump.

Synchronous-motor drives for these pumps were given consideration, but it is believed that with the small storage available, the equipment selected will in many respects give a more satisfactory installation.

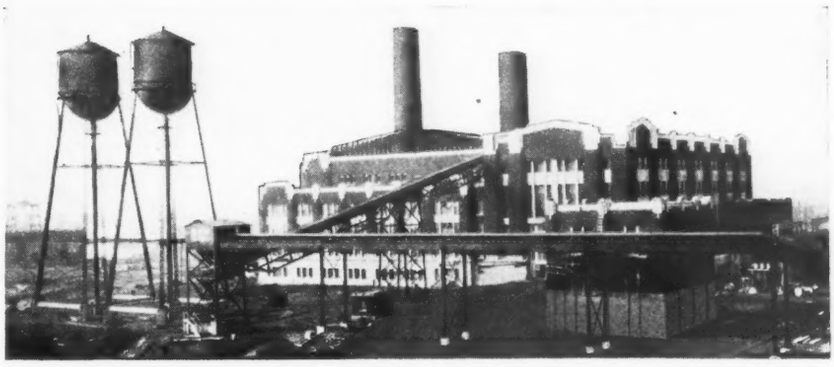
King of High Pressure

AMERICAN GAS & ELECTRIC Company has authorized construction of an extension to its Twin Branch plant at Mishawaka, Ind., to operate at the record high pressure of 2,500 lb. per sq. in. and at the temperature of 940 F. Although there have been experimental test boilers that have used pressures above 2,500 lb., this is the highest pressure yet proposed (almost twice as high) for an American commercial installation.

The General Electric Co. has been awarded the contract for a 22,500-kw., 2,400-lb. turbo-generator which will be cross-compounded with a new 40,000-kw., 400-lb. turbo-generator. The contract for the 2,500-lb. boiler, coal-pulverizing mills and accessories has been awarded to Babcock & Wilcox Co. Ingersoll-Rand Co. will supply the 3,000-lb. per sq.in. boiler-feed pumps.

2,500 lb. was selected as being the limit to which natural-circulation boilers can be built. Any higher pressure would involve forced circulation of water within the boiler by pumps with attendant pumping difficulties. American Gas & Electric Co.'s engineers have been studying the 2,500-lb. development for some time.

A view of the original Twin Branch power plant as it looked shortly after its completion in 1925



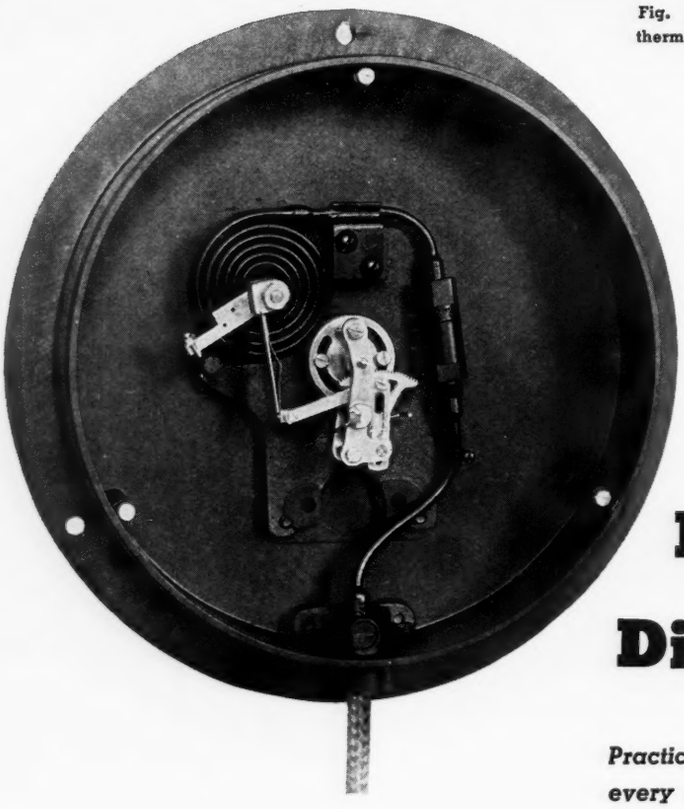


Fig. 1—Internal working parts of a mercury-actuated dial thermometer are similar to a Bourdon-tube pressure gage

Mercury-Actuated Dial Thermometers

Practical information on construction and operation that every one who uses these instruments should know

By E. H. Hammond

Chief Engineer, American Instrument Division, Manning, Maxwell & Moore

THERMOMETERS occupy a place of first importance in power-generation, industrial and other processes. Many of these applications require instruments of the dial type, of which there are four general designs: mercury-actuated, vapor-pressure actuated, gas-actuated and liquid-actuated, the mercury-actuated type being the subject of this article. Other designs will be treated subsequently.

The bulb, capillary, and Bourdon spring of mercury-actuated thermometers are made of steel or steel alloy to prevent amalgamation with the mercury. Connections and joints are welded, thus providing a hermetically sealed all-steel system of great strength and durability, Fig. 1.

A properly fabricated mercury-actuated dial thermometer is the most powerful, rugged, positive, and durable of all dial thermometers. Good practice calls for working pressures within the system as high as 2,500 lb. per sq.in. at the temperature-range top. Because of this high pressure and all-steel construction, it is possible to use an extremely stiff spring which gives rigidity to the operating and indicating mechanism and power for actuation. Power available for actuating any dial thermometer is measured directly by the amount pressure in the system changes for a change in bulb temperature corresponding to a given percentage of the range. This pressure change in a mercury-actuated system is much greater than for any other type.

Thermometer systems are highly evacuated to remove as much air as possible from them, then are filled solid with mercury. The degree of evacuation will determine the uniformity of spring deflection per increment of temperature change, and must be carefully controlled. In the better grades, some means is provided for applying and maintaining a definite and predetermined initial pressure in the system after it is filled.

Residual Air

No matter how carefully a system is evacuated, there still remain slight amounts of residual air, which may be released from the inner wall of the bulb by heating, or from the mercury. This air causes a slight deviation at low pressure from a straight-line spring deflection as a function of temperature change. Subjecting the filled system to high initial pressure compresses residual air to such a small volume that its effect is negligible, thus giving the thermometer a uniform scale throughout its range, Fig. 2. High initial pressures are also used to prevent scale error due to bulb elevation, as will be discussed later.

Every mercury-actuated dial thermometer which is not compensated, will have a small line error resulting from temperature changes along the capillary, because the capillary is filled with mercury, and is responsive to temperature changes just as is the bulb. The capillary may be considered as a second bulb, and its effect on pointer deflection will depend on the ratio of the mercury volumes in the capillary and bulb. The pointer cannot differentiate between changes in bulb temperature and changes in line temperature. Therefore, line error is inherent in mercury-actuated dial thermometers. This error may be kept negligible by keeping the capillary volume small compared to bulb volume, which is done by using capillary of extremely fine and accurate bore. Steel capillary is now available with a 0.006-in. bore maintained uniform in lengths of 200 ft. or more. Because the capillary bore is so fine, only mercury of the highest degree of purity can be used, otherwise the bore would become plugged. One manufacturer triple-distills all mercury, and maintains a purity of 99.98%.

Since line error is directly proportional to the length of capillary, and there is a limit to the smallness of its

bore, compensation for line error will be required for extremely long lines. One of the simplest forms of compensation is an additional Bourdon spring, Fig. 3. This is connected to the system in parallel with the actuating spring, but not to any operating part of the mechanism. Its purpose is to absorb half the mercury which otherwise would be forced into the operating spring because of line-temperature changes, and thus cuts the line error in half. If necessary, two, or even three, dummy springs may be added. The line error will be reduced in exact ratio to the number of springs used, but the volume of the bulb must be increased in direct proportion to the number of springs.

Occasionally capillaries are so long, and the temperature change along them so great, that full compensation will be required, which may be obtained by using an extra system comprising a Bourdon spring and capillary, but no bulb. This compensating capillary is the same length as the operating one and encased in the same armor. The two Bourdon springs are connected to the pointer through a differential linkage in such a manner that the movement of the compensating spring is subtracted from the movement of the operating spring for a rise in temperature and added to for a decrease in temperature, Fig. 5. The operating spring indicates the true bulb temperature plus or minus the line error, and the compensating spring subtracts or adds the line error. Thus, only the true bulb temperature is indicated by the pointer.

There is another form of compensation which sometimes is used, and which was first developed by Negretti & Zambra of London, England, in 1920. This method uses a relatively large-bore capillary through which is pulled an Invar wire of the same length as the capillary. The theory is that the capillary bore will expand with an increase of temperature much more than will the Invar. By correctly proportioning area of Invar wire to capillary bore area, the differential expansion between the two can be made approximately equal to that of the mercury in the capillary. Thus the capillary will tend to be self-compensating, and there will be no appreciable error as a result of changes in line temperature.

Well designed instruments have their spring or actuating linkage equipped with a bimetallic compensator which corrects for errors due to expansion or contraction of the mercury in the Bourdon spring. This is known as case compensation, therefore no account is taken of spring volume when figuring line error.

A mercury-actuated dial thermometer must be corrected for bulb elevation only when this elevation exceeds a certain height, determined by internal

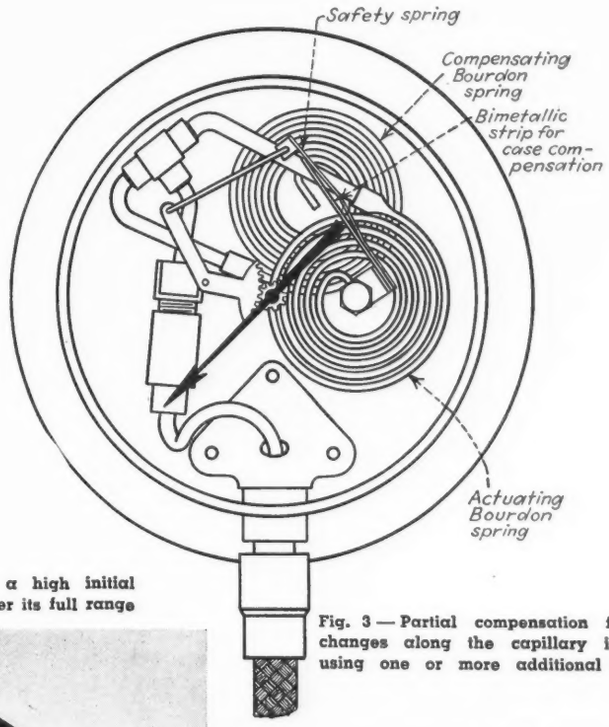


Fig. 3 — Partial compensation for temperature changes along the capillary is obtained by using one or more additional Bourdon tubes

Fig. 2 — Mercury in the system is subjected to a high initial pressure to give the thermometer a uniform scale over its full range

pressure of the thermometer system. The two following statements are true for any mercury-actuated dial thermometer in which the system is free of air and which has an initial pressure:

1. Bulb Lower Than Instrument—The instrument calibration is not affected, and no correction for bulb elevation is required.

2. Bulb Higher Than Instrument—The instrument calibration will not be affected and there will be no bulb elevation error unless the hydrostatic pressure due to bulb elevation exceeds the internal pressure in the system when there is no bulb elevation.

The proof of these statements is easy to demonstrate. The system has been highly evacuated, and then filled solid with mercury under initial pressure. No change in pointer reading can occur unless there is a deflection of the Bourdon spring, and there can be no deflection unless the

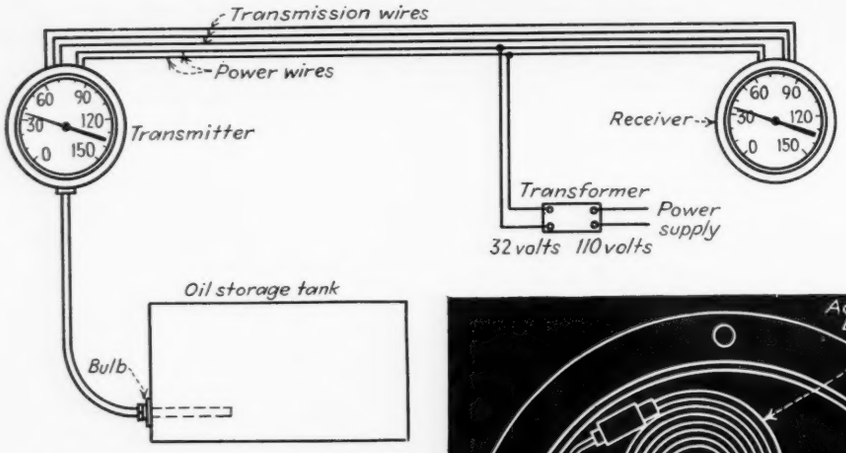


Fig. 4 — How mercury-actuated thermometer readings may be transmitted over long distances

volume of mercury in the spring changes. Placing the bulb below the instrument will not cause any change in mercury volume in the bulb, unless one wishes to be strictly academic and consider that the hydrostatic head will cause a minute distortion of the bulb. For ordinary line lengths, this error would be too small to read on the dial of a commercial thermometer.

Consider an installation where the bulb is above the instrument. The Bourdon spring already has been deflected an initial amount by the internal pressure. Therefore, there can be no further deflection of the Bourdon spring due to bulb elevation until the hydrostatic pressure exceeds the initial internal pressure. Mercury exerts a hydrostatic pressure of approximately 6 lb. per sq.in. per ft. of elevation. To prevent any possibility of bulb elevation error, the bulb elevation above the instrument in feet should not exceed one-sixth of the internal pressure at the lowest temperature of the range. This initial pressure will vary from 200 to 500 lb. per sq. in., depending on the make of thermometer.

Range Limits

Mercury-actuated dial thermometers can be built for almost any range between the limits of minus 38 F and plus 1,000 F. Mercury freezes at minus 40 F., so this determines the minimum temperature for which a mercury thermometer may be used. The upper temperature limit is determined by the strength and behavior of metal bulbs at high temperatures, and usually is fixed at 1,000 F. However, because of the creep of steel at elevated temperatures, it is not recommended that the bulb be held at this high temperature for a prolonged length of time.

Although the maximum range is minus 38 to plus 1,000 F, ranges as short as 25 F may be obtained. For manufacturing reasons, the shortness of the range may be limited by the initial or lower temperature of the range; thus, a range of 500 to 550 F might be more difficult to manufacture and calibrate than would be a range of 0 to 50. The only other practical limitation to the shortness of the range is the permsisible size of the bulb, as its size will be inversely proportional to the range. Thus the volume of a bulb for a range of 30 F. will be ten times the volume of a bulb for a range of 300 F. The actual volume of a bulb for a given range is determined by the expansion factor of the spring.

Mercury-actuated dial thermometers respond quickly to temperature changes at the bulb; that is, the thermometric lag is small. However, thermometer lag is influenced by the medium around the bulb; the shape and design of the bulb; and whether or not the bulb is used in a separable socket. As to bulb design, the bulb surface area should be a maximum for a given bulb volume. If a separable socket must be used it should be as thin-walled as maximum service pressure and temperature will permit, and its mass of metal should be a minimum.

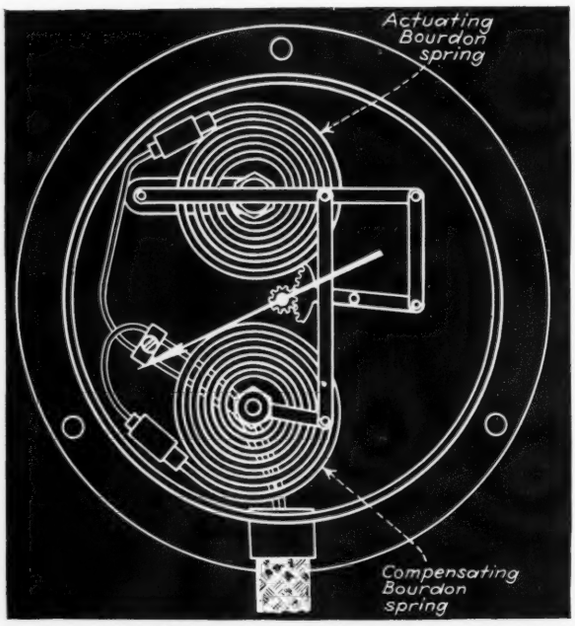


Fig. 5—A capillary and Bourdon tube are added to the system to compensate fully for temperature changes along the capillary

When considering speed of response, or lag, of a thermometer the bulb may be considered as a heat exchanger which must serve to either absorb or give up heat. Bulb efficiency is determined by well-established factors which govern design and efficient operation of heat exchangers. There are no mysterious secrets or newly discovered physical laws which will make one bulb faster than another — thermometric fluid and service conditions being equal.

A mercury-actuated dial-thermometer bulb averages the temperature to which it is exposed. This is a highly desirable characteristic, as it tends to eliminate effects of temperature stratification or zones. The bulb can be made almost any desired length, as for example, in a fluegas thermometer the bulb may be 10 or 15 ft. long.

By virtue of their greater power, mercury-actuated dial thermometers are particularly well suited for services where loads in addition to that imposed by the indicating mechanism must be carried. For example, they may be used to actuate a Selsyn transmitting motor, Fig. 4, which in turn will synchronize with a remotely located Selsyn receiving motor. The receiving motor operates the pointer of the receiving instrument to reproduce accurately the temperature as indicated by the dial thermometer of the transmitting unit, which may be several miles apart. This type of thermometer also is quite often used to operate electric contacts and switches, or pneumatic-control devices.

Engine Overspeed

WHAT MAY happen when a diesel or other internal-combustion engine is permitted to run over designed speed is illustrated by the crankshaft failure of an English diesel designed to run at 240-250 r.p.m.

Failure took place at the main journal, and at first torsional vibration was suspected. However, owners had at an early stage in the life of the engine increased engine speed to 260 r.p.m.; then, after three months had reduced speed to normal again.— Abstracted from *Technical Report for 1935 of the Royal Insurance Co., Ltd.*

Troubles with Evaporators

When an evaporator acts up, don't consign it to perdition. More than likely conditions are responsible, for a water treatment perfect in one plant may be useless in another

By Frank Martin
Supt. of Utilities, Hinsdale, Ill.

SEVERAL YEARS ago, a large power plant reported difficulty with a large horizontal, steam-heated evaporator which supplied makeup to its feedwater system. The contract specified a maximum of 0.5 gr. per gal. of solids in evaporated water at all capacities, but the recording resistance-measuring instruments showed that water varied from less than 0.1 to over 1.6 gr. per gal. without any apparent cause. Evaporation tests showed that instruments were recording correctly.

The figure shows the general arrangement of the evaporator. Raw water entered the shell at the bottom near one end, while evaporated water, in the form of steam, passed around each end of a dividing plate or baffle over the tube bundle, and left the evaporator shell through two carefully baffled steam cleaners. The tube bundle was fed with steam from the top of the evaporator shell, and was mounted on rails and rollers so that it could be withdrawn from the shell by only breaking two pipe connections, the steam feed at the top and the drain at the bottom.

Inspecting the Unit

Steam for heating was extracted from the turbine at 25 to 50 lb. per sq. in., depending on load. The several steam passages in the evaporator were designed for a steam velocity of 4,000 to 6,000 f.p.m. at maximum capacity.

A careful inspection of both the interior of the shell and the tube bundle was made. We inmmediately noticed that the end of the shell where the water entered was very clean, while the opposite end was covered with a thin layer of scale, except for a 12-in. circular spot on the head near the center and above the division plate.

The tube bundle also was clean on the end where raw water entered the shell, but showed signs of scale on the top and at the opposite end, i.e., in the same location as the shell. This indicated that water circulation was carrying foam to the end of the shell away from the point of entrance of the water. Foam was building up at that end until the steam passing through on its way to the steam space was picking it up and carrying it over into the evaporator condenser. This foam mixed with the evaporated water and carried enough solids to ruin the makeup water.

Since the foam appeared to be concentrated at one end of the evaporator shell, we installed a cross-baffle in that end of the steam space, shutting off that end from the water space below. This forced all steam to pass around the opposite end of the dividing plate and doubled the velocity of steam travel at that point; however, we thought that this would not cause any trouble. The evaporator, back in service, continued to give almost as erratic results as before.

Additional Baffles

After careful consideration, two more baffles were installed, a horizontal baffle at the intake end of the shell just over the top of the tube bundle and a vertical baffle at the extreme end of the tube bundle, *C* and *D* in the figure. These baffles did not shut off the water space from the steam space at the intake end, but they tended to retain any foam which might be on the top of the water at this point and prevented steam passing over the water to the upper space from coming in contact with this foam.

The evaporator was again put into service. After the steam space and piping became clean, the quality of the evaporated water improved to less than 0.15 gr. of solids per gal. This work was done several years ago, and the evaporator has been working satisfactorily ever since.

A somewhat different type of trouble was experienced at another station. Here the evaporator was designed to use steam extracted from the turbine at low pressure. When started under these conditions, the evaporator performed according to expectations. The necessary amount of water was evaporated without difficulty, and quality was satisfactory. Cold water was introduced to contract the tubes sharply and crack off scale, which was then carried out of the shell by blowdown.

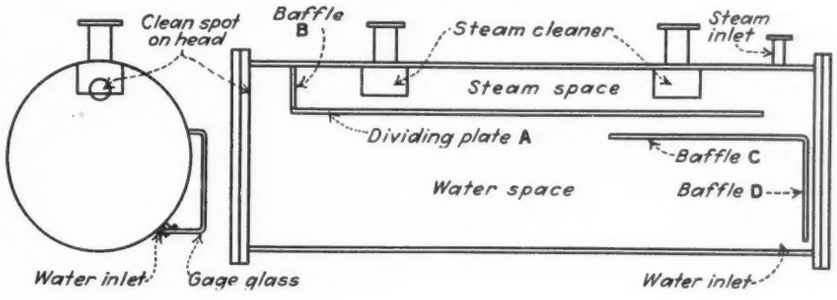
Scale Troubles

After the plant had been in operation for some time, more water was required. After consulting with the manufacturers, we piped the steam coils of the evaporator to a higher-pressure extraction point in the turbine. At first everything appeared to be satisfactory, and no trouble was experienced. The evaporator gave the desired capacity and satisfactory quality. However, it was shortly found that the scale no longer cracked off when the evaporator was blown down but had to be cleaned by hand after opening up the evaporator.

Examination showed that scale formed at lower temperature and pressure was hard and brittle and therefore cracked off easily with change of temperature, but at higher temperature and pressure was tough and rather flexible and would not crack off. After a great deal of study and experimentation the idea was abandoned and the evaporator returned to original operating conditions.

This example shows that the same water under different conditions will give entirely different results. Consequently, a water treatment which works perfectly for one plant may be useless in another under slightly different conditions.

Steam-heated evaporator showing baffles installed to make constant the amount of solids



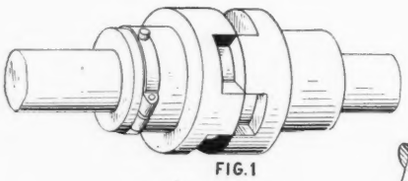
FRICTION CLUTCHES—I

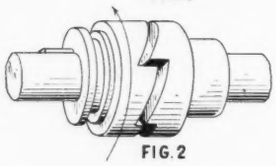
The first of two articles explains the construction and operation of several designs of axially operated single- and multiple-disk and radially operated single-disk clutches

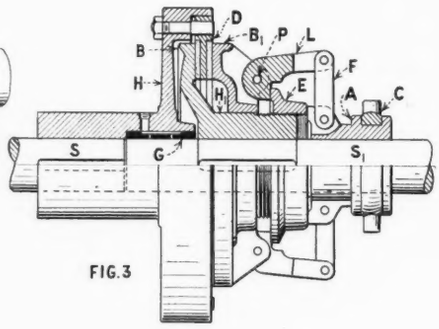
IN MANY POWER applications it is desirable to connect and disconnect the power source and load at will. In others, application problems are simplified and costs reduced by bringing the power source up to part or full speed before connecting the load. For these and other types of drives, clutches are used. Clutches may be divided into three general types: jaw, friction and hydraulic, or a combination of the latter two. Only the first two classes will be considered here.

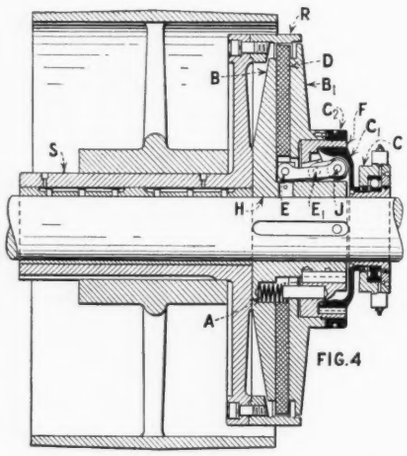
Jaw-type clutches are of two general designs: square-jaw, Fig. 1, and spiral-jaw, Fig. 2. The square-jaw type is usually made with three jaws, Fig. 1, and the spiral-jaw design with four jaws, Fig. 2. These types are the simplest and lowest in cost. For cutoff couplings, one half of the clutch is keyed to the end of one shaft and the other half is splined to the end of the other shaft, a lever engaging and disengaging the clutch. For power takeoffs, one half of the clutch may be cast to the hub of a sprocket pulley or gear mounted to run free on the shaft. The other half is splined to the shaft for meshing with the half on the gear or sprocket hub.

They are suitable for slow speeds where they can be engaged when the shaft is motionless. If disengaged when the shaft is in motion, the load should be light to prevent over-stressing the jaws when they approach the disengaged position. If reversed torques are likely to be experienced, then only the jaw type should be used, as the spiral type will open if its direction is reversed.









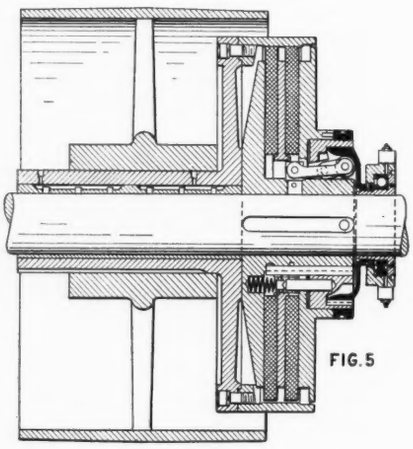


Fig. 1—Square-jaw clutch. Fig. 2—Spiral-jaw clutch. Fig. 3—Single-disk axially operated clutch of the cutoff-coupling type. Fig. 4—Single-disk, axially operated clutch of the power-takeoff type. Fig. 5—Multiple-disk, axially operated clutch of the power-takeoff type

Development

Friction clutches have been developed in a multitude of designs and are both magnetically and mechanically operated. For a description of magnetic types see *Power,* October, 1936, page 538. Friction clutches may also be manually or automatically operated. For information on automatic types, see *Power,* January and July of this year, pages 6 and 386.

Manually operated friction clutches have been developed in a great many forms, such as single-disk, multiple-disk, single-faced and double-faced disk, radially operated, axially operated, compression expanding, cone, coil and others. All are built to be applied as cutoff couplings or as power takeoffs. In the former applications, they simply act to connect a power source to its load or as a disconnect coupling between two halves of a long lineshaft. In power takeoff applications, one half of the clutch is built into a pulley gear sheave or sprocket in which the shaft runs freely when the clutch is released. The other half of the clutch is splined on the shaft, and when the clutch is engaged, drives the power takeoff.

A friction clutch may be considered a modified form of mechanical brake. A brake connects a moving machine to a stationary object to stop it, where a clutch connects a machine to a source of driving power. Both depend upon friction between two or more surfaces to accomplish this purpose. Friction clutches have been made in almost countless designs, a few of which will be discussed here to give a general idea of their construction principles.

Fig. 3 shows a single-disk coupling-type clutch. Disk D with its double-friction surface is bolted to flange H, the hub of which is keyed to shaft S. The clutching mechanism is keyed to shaft S_1, the end of which runs in a pilot bearing G in hub H, to insure alignment between the two halves of the clutch. The clutch is engaged by shifter sleeve A, which is free to move with it in collar C. This collar connects to a lever by which sleeve A is moved axially to engage and disengage the clutch.

Friction Disk

The fricton disk runs between two metal surfaces, B and B_1. B is part of hub H_1, B_1 being carried on the hub and free to move axially under control of the operating mechanism. Levers L pivot on B_1 at P, contact adjustable collar E and connect to sleeve A by links F.

The clutch is applied by moving shifter sleeve A to the left, which,

through links F forces the right-hand ends of L outward to turn them around pivot P. This produces a heavy reaction in levers L, pressing on adjustable collar E and friction plate B_1, to grip the friction ring between plates B and B_1. The clutch is released by moving sleeve A to the right to permit levers L to move a short distance toward the shaft. When the friction surfaces or other parts wear, adjustment can be made by turning collar E on its threaded connection with hub H_1.

Fig. 4 is a single-disk type, as in Fig. 3, but arranged for power take-off. Sleeve S is free to rotate on a lubricated bearing on the shaft and connects to external driving ring R. On the inside of R are gear teeth into which mesh teeth on the outer periphery of friction disk D. This arrangement permits the friction disk to take a free running position between friction plates B and B_1 when the clutch is disengaged.

Hub Keyed On

Hub H is keyed to the shaft and cast as part of friction plate B. Friction plate B_1 is moved axially by the operating mechanism, which is controlled by a lever attached to collar C as in Fig. 3. A toggle mechanism connects to friction plate B at E and to the movable friction plate at E_1. To release the clutch, collar C_1 is pulled to the left by the operating mechanism, toggle joint J moves upward to free friction plate B_1, and the friction disk is released by spring A. The reverse operation engages the clutch. Only one toggle mechanism and one releasing spring are shown in the drawing, but to insure equal distribution of pressure on the clutch parts, three or more of each are used. Adjustment of the clutch is made by collar C, threaded onto extension F.

A multiple-disk clutch of the same type as the single-disk, Fig. 4, is shown in Fig. 5. This design has two double-faced friction disks with a pressure disk between. Friction disks have gear teeth that mesh into teeth on the inside of the external driving ring. The pressure plate has teeth on its inner periphery that mesh into teeth in the hub, so that the disks are free to adjust themselves axially. This permits free running when the clutch is released and equal distribution of pressure on the friction elements when the clutch is engaged. Multiple-disk designs permit greater capacity for a given outside diameter than is possible with single-disk types. Some designs of multiple-disk clutches have seven or more friction disks.

In the cutoff-coupling clutch, Fig. 6, a disk ring D is supported on arms from a hub B keyed to shaft S. The friction elements, usually 6 in number, are faced with wood and supported within the pulley. Levers L are fulcrumed at F. Then, when the right-hand ends of these levers are forced outward by moving sliding collar C to the position shown, the friction elements grip disk D to couple the two shafts together. Moving the sliding collar C to the left releases the clutch.

The clutch, Fig. 7, is applied by screws instead of levers. Three small gear wheels G have their stems threaded into the right-hand friction plate P. Rods R fixed in the operating collar carry teeth that mesh into gears G. When the operating collar is forced to the right, toothed rods R turn gears G to pull the friction plates P and P_1 together to grip the friction ring and engage the clutch.

Where reversing drives or two speeds are required from a constant-speed power source, a duplex clutch, Fig. 8, may be used. For reversing service, an open-belt drive from the power source connects to a pulley on one clutch, and a crossed belt connects the power source to a pulley on the other clutch. For 2-speed service, the pulley ratio from the power source to one clutch is different from that of the other drive. In reversing service, the forward speed may be made different than the reverse speed by making the pulley ratios different.

Friction elements in the clutch of Fig. 8 are hardwood-block inserts H held in an iron ring so that end-grain surfaces come in contact with the surfaces of two iron friction plates. Bolt B connects the inner end of lever L to the free friction plate F, and a toggle T forms a fulcrum between L and friction plate F_1 cast to the hub. When levers L are forced outward as the operating sleeve is pushed toward the clutch, they draw the friction plates together to grip the wood-block friction element.

Radial Friction Elements

Several designs of clutches have friction elements which operate radially instead of axially. A simple type of single-acting radially applied clutch is shown in Fig. 9. Four lever arms L that carry the friction elements are fulcrumed in the pulley arms. The friction elements F, which are like brake shoes, are applied to an iron pulley fixed to the shaft. The large wood pulley is free to run on a sleeve extension of the clutch pulley when the clutch is released.

A double-acting radially applied clutch is shown in Fig. 10. The pulley with a friction band attached to its spokes can run freely when the clutch is released. Each pair of friction elements connects to the ends of a bar B, which is pivoted at P. Levers L are fulcrumed at F and have their

Fig. 6—Friction clutch with wooden friction shoes built into pulley for flat belt. Fig. 7—Friction clutch applied and released by worm-and-gear mechanism. Fig. 8—Double clutch used for reversing and 2-speed service

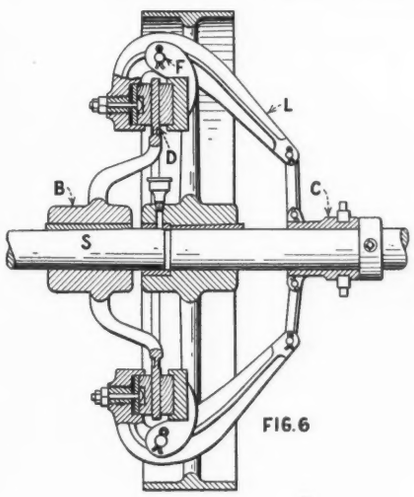


FIG.6

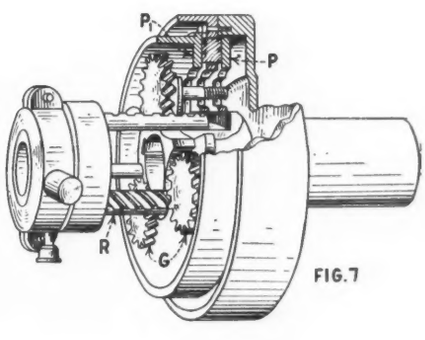


FIG.7

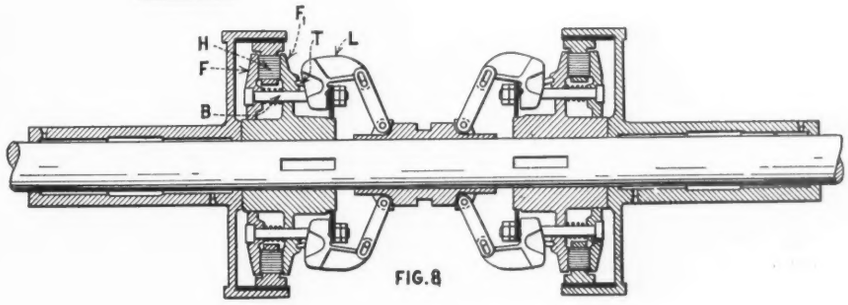


FIG.8

left-hand ends so shaped that when the right-hand ends are forced outward bars *B* rotate on their pivots *P*.

The bars force the inner clutch shoes outward and the outer clutch shoes inward against clutch ring *R* to connect the pulley to the shaft so that one may be driven by the other.

Several other designs of this type of clutch are available, but they all operate on the general principle of those in Figs. 9 and 10.

A second article will consider other types such as expansion, compression, cone, and coil designs and data for use in selecting clutches.

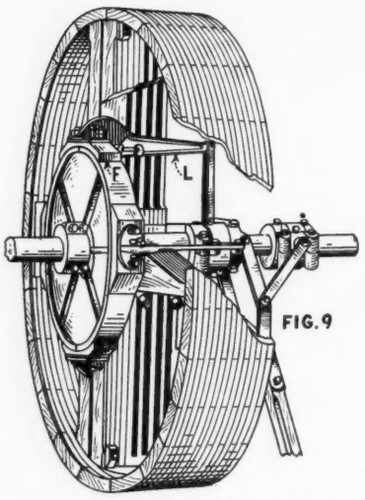


FIG. 9

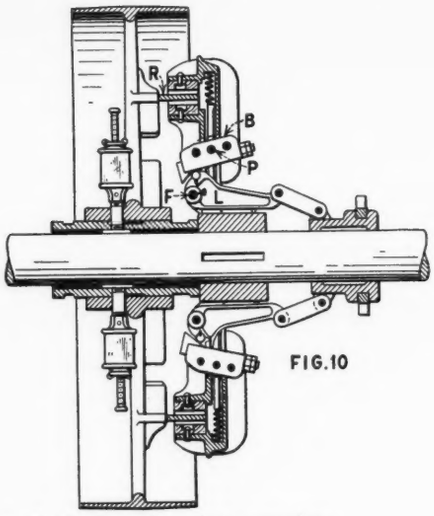


FIG. 10

Fig. 9—Radially applied friction clutch built into large wooden pulley. Fig. 10—Radially applied clutch with double friction elements

For information from which this article is prepared, POWER is indebted to Dodge Mfg. Co., Reeves Pulley Co.; Link Belt Co.; Allis Chalmers Mfg. Co.; Stephens-Adamson Co.; Morse Chain Co.; Hilliard Corp.; Medart Co.; W. A. Jones Foundry & Machine Co.; Twin Disc Clutch Co.; Chain Belt Co.; Foote Bros. Gear & Machine Corp.; Falls Clutch & Machine Co.; Chicago Pulley & Shafting Co.; Diamond Iron Works; Wolf Co.; T. B. Wood's Sons Co.; Hill Clutch, Machine & Foundry Co.; Brown Engineering Co.; McMahon & Co.; Filler & Stowell Co.; Conway Clutch Co.; Erie Clutch & Pulley Co.; Franklin Valveless Engine Co.; Edgemont Machine Co.; Pusey & Jones Co.; E. J. List Co.; Bagley & Sewall Co.; Webster Mfg. Co.; Snow Petrelli Mfg. Co.

Ultra-Modern Hookups for Byproduct Power—II

Concluding the article started in August Power, this installment shows the familiar "top" in a Swiss variation designed to cut energy loss to the ultimate minimum

BASED ON information furnished by Sulzer Bros., Winterthur, Switzerland, the first section of this article presented simple flow diagrams and showed how the familiar process of byproduct power generation can be perfected by using steam accumulator, evaporator and other devices, and by superimposing a high-pressure "single-tube" steam generator and turbine on an existing low-pressure plant.

Complicated Hookup

This concluding installment is devoted exclusively to an explanation of the hookup here shown, which is presented with some hesitation because many American industrial power engineers will view with suspicion an arrangement so complex and involving so many automatic regulating elements.

In the eyes of Sulzer engineers, however, this complication is fully justified by the remarkable fuel savings it makes possible. Without changing total coal consumption or process-steam load, the modernization described increased electrical output from 2,700 to 6,550 kw.

In the original plant a number of boilers supplied 230-lb. live steam to a 2,700-kw. condensing turbine. Process steam, also generated at 230 lb., was lowered to 110 lb. through a reducing valve. Conditions called for the maximum of power production without increasing the supply of process and heating steam. This, of course, required generating process steam in a high-pressure boiler, using turbines as reducing valves.

The high-pressure steam generator *EK*, consisting of several lengths of tubes in parallel, delivers up to 120,000 lb. of steam per hr. at 840 F, and pressure ranging from 1,400 to 1,600 lb. Economizer *E* and superheaters ZU_1 and ZU_2 are situated in the flues.

Although 115-lb. pressure is ample for the heating steam, the high-pressure turbine was arranged to exhaust at 230 lb., the pressure of the retained low-pressure boilers. This permitted using a straight high-pressure turbine without bleeding. It also gave a greater temperature difference between steam and water in the evaporator *DT*, thus greatly reducing its size and cost.

Geared H. P. Turbine

The multi-stage high-pressure turbine *HT* drives the 4,300-kw. electric generator G_1 through a reduction gear. Since this turbine expands all of the high-pressure steam produced, its gen-

HEAT BALANCE

Heat Introduced		*Heat Utilized or Lost*	
Coal	100.0%	Power developed	13.4%
Low-pressure steam	4.0%	Superheated steam used for process work	32.6%
Feedwater	1.1%	Dry saturated steam used for process work	22.4%
		Various losses	36.7%
Total	105.1%	Total	105.1%

erator is electrically paralleled with that of the low-pressure turbine *NT*, which is governed to run at constant speed. The valve of the high-pressure turbine is set to serve purely as an overspeed safety. As a result, all load variations are first taken by the low-pressure side of the plant, while governor D_1 maintains a constant steam pressure of 1,550 lb. at the superheater outlet. Any surplus high-pressure steam spills over to the evaporator through an overflow valve (not shown).

Normally, about two-thirds of exhaust steam from the high-pressure turbine goes to the evaporator through valve DV_1, controlled by temperature regulator TR_2. The remaining third passes over the intermediate superheater ZU_1 to low-pressure turbine *NT*. If temperature in the intermediate superheater exceeds 450 F, valve DV_1 partly closes, thus increasing steam flow through the intermediate superheater.

If steam admitted to the low-pressure turbine is suddenly and strongly throttled when steam valve DV_1 is closed, exhaust from the high-pressure turbine passes to the evaporator through the non-return valve RV_1. Condensate forming in the evaporator collects in tank *KS*. Float-operated valves SV_1 and SV_2 control flow of condensate to tank *AB*, which overflows to *SB*. Condensate from surface condenser *C* goes through pump KP_1, tank *AB* and pump KP_2 to the evaporator.

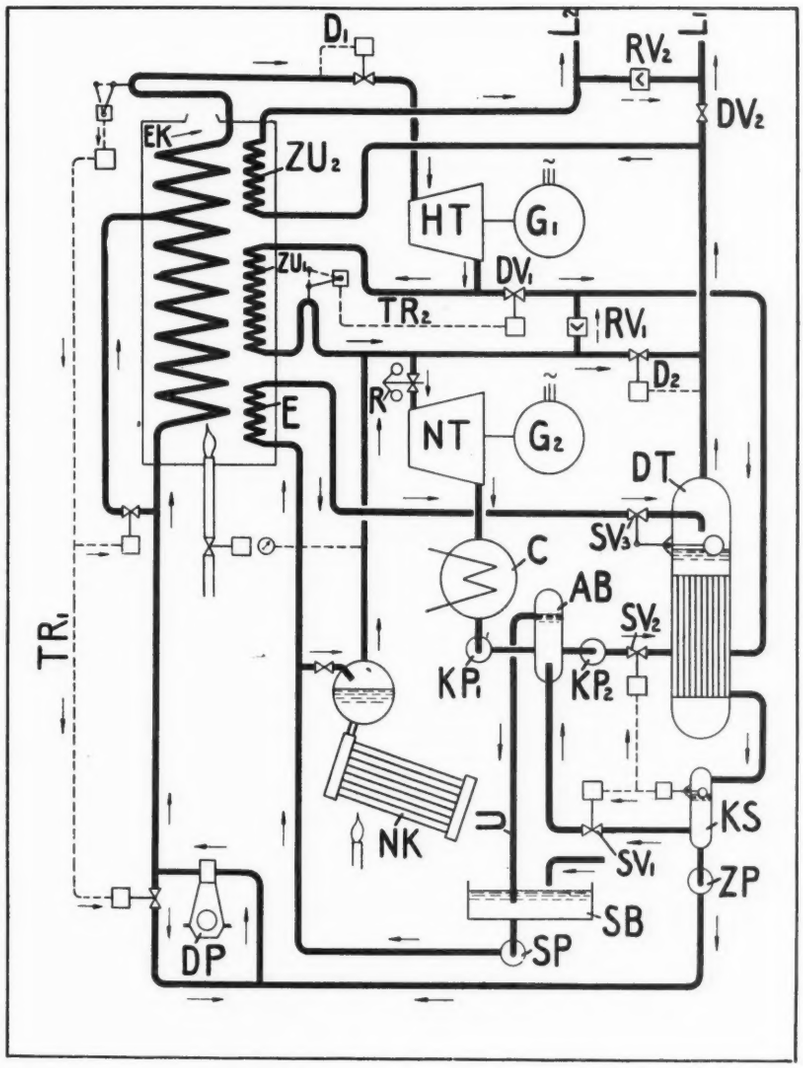
Condensate from tank *KS* passes through pump *ZP* and triplex feed pump *DP*, to high-pressure generator *EK*. The pump *SP* serves the low-pressure boiler *NK* and also evaporator *DT* through the economizer *E*. Float-valve SV_3 regulates supply of condensate to the evaporator. In steady operation a little condensate always overflows through pipe *U* into tank *SB*, which is under atmospheric pressure and from which the low-pressure boiler and evaporator are fed.

Steam generated at about 115 lb. in the evaporator is led to heating and process applications through pipes L_1 and L_2. Normally, steam in L_2 is superheated somewhat by partly closing valve DV_2, thereby forcing steam through the coil ZU_2. Non-return valve RV_2 allows steam to pass from L_2 to L_1 when the pressure in L_2 exceeds a certain level.

Pressure regulator D_2 in the 230-lb. system constantly spills a small quantity of steam into the 115-lb. system to maintain its pressure. Load variations of the low-pressure turbine are taken by the 230-lb. boiler.

Combined high-pressure and back-pressure plant, designed for maximum production of byproduct power

EK	Single-tube boiler
E	Economizer
ZU_1	Superheater
ZU_2	Superheater
D_1	Pressure regulator
D_2	Pressure regulator
RV_1	Non-return valve
RV_2	Non-return valve
DV_1	Throttle valve
DV_2	Throttle valve
TR_1	Temperature regulator
TR_2	Temperature regulator
HT	High-pressure turbine
NT	Low-pressure turbine
G_1	Electric generator
G_2	Electric generator
R	Speed governor
DT	Steam transformer (evaporator)
C	Condenser
SV_1	Float valve
SV_2	Float valve
SV_3	Float valve
KP_1	Condenser pump
KP_2	Main pump
KS	Condensate tank
AB	Compensating tank
SB	Feedwater tank
SP	Feed pump
ZP	Feeder pump
DP	Triplex pump
U	Overflow pipe
NK	Low-pressure boiler
L_1	Steam pipe
L_2	Steam pipe



Kw. Output Increased 145%

Temperature at the superheater outlet and also the quantity of feedwater are regulated in the usual manner. Firing rate of the high-pressure steam generator is regulated to maintain constant steam pressure in the distributing pipes from the low-pressure boiler.

The table shows how small the losses are and how great the gain in power. For the same output of process steam, and burning the same weight of coal (17,000 lb. per hr.), the net electrical output is increased from 2,700 kw. to 6,550 kw. by the conversion.

In general, engineers of Sulzer Bros. conclude, the addition of a high-pressure "top" can be recommended when both electrical and heat energy are required at the same time and in large quantities, as in paper mills, breweries, sugar refineries, bleacheries, dye works, chemical works and district-heating plants.

STEAM:

To Make Or Buy?

A case-history study reveals that there are no hard and fast rules, but a careful study of all factors will determine whether district or self-generated steam is the most economical

By Robert H. Emerick

WHEN it comes to making a choice between buying steam and making it yourself, the crux of the matter is usually economic. Will it pay, or won't it? Many considerations will, and should, affect the decision. However, a recent analysis of new customers on the lines of a district heating company in a large city showed that more than half of them expected to make a saving by shutting down their own plants.

Does this indicate that the engineers of private plants are less efficient and wide-awake than they might be? Or is it just that the large central plant can produce steam at a rate too low for individual competition?

Case Histories

Let's see what we can find by examining several case histories.

One is a large bank building. It has two 1250-sq. ft. low-pressure heating boilers fired by chain-grate stokers. Except for the hot-water generator, there is no other equipment in the boiler room. Operating personnel consists of one licensed engineer and three firemen working in shifts.

The owners, finding themselves facing a heavy outlay for new stokers, decided to investigate the purchase of steam. Annual plant operation they found was costing over $11,000:

Fuel	
900 tons of coal at $5 average..	$4,500
Ash removal.....	250
Pay-roll	
1 engineer at $35.....	1,820
3 firemen at $25.....	3,750
Other Expenses	
Insurance	100
Electricity for stoker and fan motors, water, miscellaneous supplies, estimated.....	100
Sundry maintenance.....	100
Accrued maintenance, or sinking fund	1,000
Total	$11,620

The district steam company, after a study of the existing conditions, recommended elimination of the boiler-room personnel and on this basis, estimated an annual cost of purchased steam at $10,500. The owners decided to contract for service, and at the expiration of the first year, the estimate being found accurate, purchase of steam is being continued indefinitely.

This case seems to indicate that you cannot buy steam, at least from a district steam company, for a price that is less than your own fuel bill. It suggests also that the strictest kind of plant maintenance is no more than financial common sense. This property owner spent approximately $1,800 to connect his system to the street steam main as the alternative to spending many times that amount for new stokers, whereas regular intelligent care of his equipment might conceivably have prevented such a choice from ever arising.

Study your own plant exhaustively before reaching any decision.

The unit cost of generation is not the complete story. The cost of connection to the street main may mean an outlay of a $1,000; and if you propose to tie to the boilers of a neighboring plant, the run may be a long one and cost twice that. How much could you improve the efficiency of your own plant by spending a thousand or two thousand dollars? Might not such an outlay change the whole economic picture of buying steam?

A Banking Institution

Let's examine another case picture. Here is a banking institution with two 1500-sq. ft., h.r.t. boilers used for low-pressure heating. A water softener, fans, water and fire pumps complete the boiler room. Boilers are stoker fired.

In the endeavor to save operating costs, the purchase of outside steam was investigated. The chief engineer found, much to his disappointment, no saving would be possible unless he disposed of one of his men.

"That," he said, "I can't do. I have only one fireman on a shift in the boiler-room. I can't do with less."

But the steam company saw the problem from a different angle. All night the fires were banked. The fireman had little to do. The watchman assigned to that section of the structure came into the boiler-room every hour. The fireman was glad of that. It broke the monotony.

The steam company figured on combining the duties of fireman and watchman. They proved it could be done without any real danger or loss of efficiency.

"You see," they said to the chief engineer. "That is how we can save one man."

And they handed him a contract to sign. But the chief engineer shook his head.

"I'll save him that way myself," he said.

The whole economic balance thus was changed, and the purchase of steam dropped. It appeared no longer favorable.

If steam for process work must be considered, however, to buy it may prove the cheaper practice, although again each case is a law unto itself. For a case in point, consider a large city club that maintained high-pressure boilers for the sole need of serving its own private laundry. Naturally these requirements were irregular and intermittent, most of the time boilers carried a greatly reduced load, and the costs of generation reflected the low over-all efficiency most irritatingly. Finally the engineer recommended they shut down the big boilers, buy steam for the normal needs of the institution, and send the linens to a commercial laundry. This was done, and a substantial saving promptly realized.

Load Fluctuations

On the other hand, the purchase of steam may be said, almost categorically, to offer no slightest attraction from the standpoint of cost, to certain processes. Dye-house engineers in particular are accustomed to seeing steam-flow charts that look like profiles of the Andes Mountains. Such fluctuations in load are extremely unlikely to find favor with any source of supply, and certainly any commercial steam company will charge for them at a rate which will make the old boilers look better than ever.

How about buying steam for the generation of electricity? The exhaust from engines or turbines can continue to be used for heating, or perhaps for some special process operation. Elimination of the boiler-room and fuel-storage requirements may release some sorely needed space, and in truth a careful study of the situation may show an attractive picture.

However, it may be impossible to buy steam for such a purpose. The commercial steam companies, being usually closely related to the electric utilities, more often than otherwise refuse to serve prime movers. A clause to that effect appears in their contracts. If you can buy steam from a neighbor though, this problem of policy is avoided. Then the economic balance becomes all-important and the value you place on special benefits becomes the deciding factor.

Evaluate All Factors

From the cases described, we can see clearly how exclusively individual each decision must be. The one common and basic law to be observed is simply this: Collect and evaluate *all* factors. If we satisfy ourselves by adding together the obvious expenses of fuel, labor, supplies, insurance, maintenance and so on and say, "It cost us $10,000 last year to generate 15,000,000 lb. of steam," we may be missing part of the story. We can depend on it that the comptroller, if our organization is large enough to have one, is charging something for building and space rental to his boiler-plant accounts. Thus, if steam is purchased and the boiler room is converted to some other use, power cost to the company is reduced by considerably more than the $10,000 actually spent for generation. Of course we can call it a matter of bookkeeping, but the fact is that outdoor boiler plants are in process of development right now, and the credit is legitimate if the space and structure can be profitably used for other purposes.

We must consider also the effects of dust and smoke. If they are actively inimical to buildings and processes, here is another item of expense chargeable to the costs of generation.

On the other hand, if we can reschedule our personnel or perhaps improve their efficiency, we should correct our $10,000 accordingly before using it in any comparison of costs. Nor must we overlook what might be done with the money required for the changeover. Whatever reduction in operating costs can be secured through that amount of outlay is a legitimate consideration in arriving at our own costs of generation.

Maintenance Still Present

Then too, what we actually pay the vendor of steam is never the whole cost. Maintenance is still around. Joints will leak and valve seats score just as before. In fact we may have more trouble than ever if the steam turns out to be excessively dirty, or burdened with oil, or if the water treatment used proves harmful to some delicate process. There may be even enough superheat present to damage thermostatic elements or other sensitive equipment.

All these factors must be considered. Each has a definite value and perhaps a far-reaching significance. Collect and evaluate *all* factors. That is the only safe rule. Then decide which course to pursue.

Exhaust Lines

By E. J. Tangerman

Out at the Iowa N.A.P.E. convention, Walt Proescheldt of Iowa Elec. Lt. & Pwr. Co. told the story of a Chief named Barney who recently starfed up his new station. A few minutes after the start-up, an awful howl and squeak developed 'way up near the top of the boiler—about 80 ft. from the operating floor. Although Barney is a heavy man, he got up there in a little under nothing flat. Barney had told his men all about the plant, of course, among other things about a new type of bearing being used on the induced-draft fan. Carelessly, he had called it an "oilless" bearing. One of the oilers took him seriously, and didn't put in any oil.

Research is the reconnaissance party of industry, roving the unknown territories ahead independently, yet not without purpose, seeing for the first time things that all the following world will see a few years hence.—S. M. KINTNER.

The Locomotive tells the story of the Hartford man who, during a boiler inspection, asked the Chief to have a fireman test the safety valve. "Oh, that will be all right," the engineer said, "the men have been told to test the safety valves every day." "Fine," said the Hartford man, "but I'm fussy about those valves and so is the home office." So the engineer sent a fireman up on top of the boiler to test the valve. It worked all right! The exhaust blew out into the yard at a point where the Hartford man could see it through the open door. With the first discharge of steam, a bird nest was blown out of the relief pipe across the yard! Daily inspection?

An enterprising citizen of Luray, Va., cools his home in summer with 60-F air drawn from the famous Luray Caverns.

Nobody ever conceived of a fan as a fly catcher, but mushroom growers are using them for just that. In summer, flies cluster so thickly over the manure beds on mushroom farms that they become a decided nuisance. So an engineer figured out a combination of a huge suction fan and refrigerating coils—the flies are drawn over the coils, which chill them, and they drop dormant down a hopper into milk cans. The cans of flies are shipped to frog growers, who chill them again and serve them to their frogs. Some mushroom growers are now getting almost as much from the sale of flies as they do from selling mushrooms.

Thomas Jefferson, statesman, author of the Declaration of Independence, founder of the University of Virginia, and one of the greatest architects of his time, may also be the pioneer in summer home cooling in this country. Architects engaged in restoration of his home, Monticello, were surprised to discover that a tunnel from the house opening on the hillside near the old slave quarters faces in the direction of prevailing winds. It also contained, in one section, provisions for dripping cold water from its roof.

Two of Sweden's largest privately owned waterfalls have been acquired by the Swedish Government Water Power Board for a total of 4,300,000 kronor. One of these, the Torpshammar Falls, in Gim River, has a height of 126 meters (413 ft.). It is expected that when developed it will have an effect of at least 85,000 kw. The annual combined kw.-hr. available from the two falls should exceed 380,000,000.

Sincerity is to speak as we think, to do as we pretend and profess, to perform what we promise, and really to be what we would seem and appear to be.—Tillotson.

A new sleeper bus has been shipped to take over the 600-mile roadless run across the scorching desert from Bagdad, Iraq, to Damascus and Beyrouth, Syria. Powered by diesel, it is also air-conditioned, because it must be air-tight to exclude the fine sand of the desert. While the air-conditioning unit is needed during a summer day to cut temperatures which sometimes reach 125 F. in the shade, on winter nights it may have to raise freezing temperatures on a high plateau. Body structure is corrugated stainless steel, insulated, of course.

For every five electric refrigerators, oil burners, washing machines, ironing machines and lesser gadgets, sold in 1935, seven were sold in 1936—meaning more power all along the line.

Keep Deaerated Feedwater Deaerated

Two simple methods of controlling condensate and feedwater to prevent contamination with air, after being deaerated in the condenser

By Ross E. Thompson
Mechanical Engineer,
Albuquerque Gas & Electric Co.

WITH MODERN methods of keeping boiler surfaces clean, corrosion and pitting is encouraged by presence of oxygen or air in feedwater, and it is important that all feedwater be deaerated. Spraying into a condenser where the vapor will give up most of its entrained air in a high vacuum is effective where flows are properly controlled.

Fig. 1 shows the Rawlins system of handling condensate and makeup water. Where a comparatively small surge tank may be installed inside the plant building or otherwise near the feedwater heater, this system can be used successfully to deaerate all makeup water in the condenser, and handle it from there to the boiler, without allowing further contact with air. The surge tank must be closed, vented at the top to the heater.

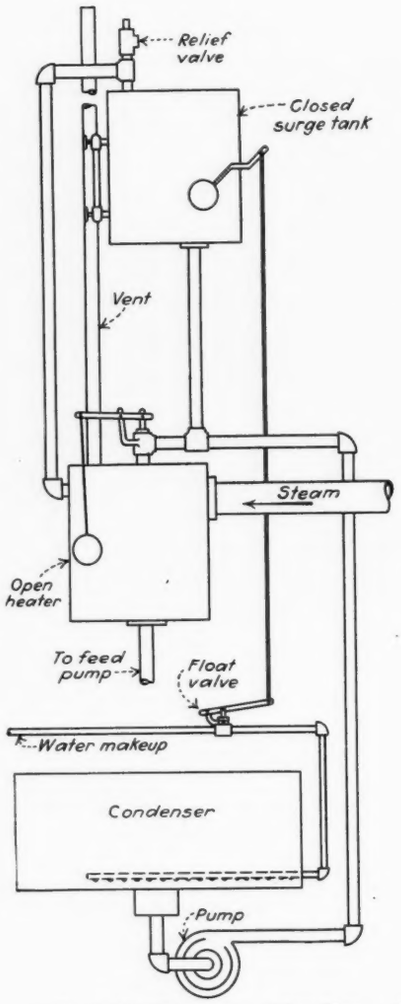


Fig. 1—Rawlins system of handling condensate and makeup feedwater

Makeup water

All makeup water for the system is introduced through a perforated pipe inside the condenser. Makeup is regulated by a float valve with its controlling float in the surge tank. No other valves are required in the feedwater system, except the float valve regulating amount of water in the heater. Success of this system depends on having a makeup-water line and float valve designed to admit enough makeup water for the system, and not too large for the condensate pump so that the condenser might be flooded. This system operates entirely automatically and requires very little attention, having no complicated valves, floats and other gadgets to get out of order.

Where the surge tank is comparatively large, is out of doors, or otherwise arranged so that it is impracticable to make it closed, as required by the Rawlins system, deaerated water may be handled as in Fig. 2, which we may call the Albuquerque system. With this system all makeup water goes into the surge tank, connected to the heater feed line through a check valve. Excess water in the heater feed line readily flows into the surge tank through the check valve. Water cannot flow directly from surge tank to heater, but is admitted through a diaphragm-operated valve to a perforated pipe that sprays it into the condenser, where it is deaerated before going to the heater.

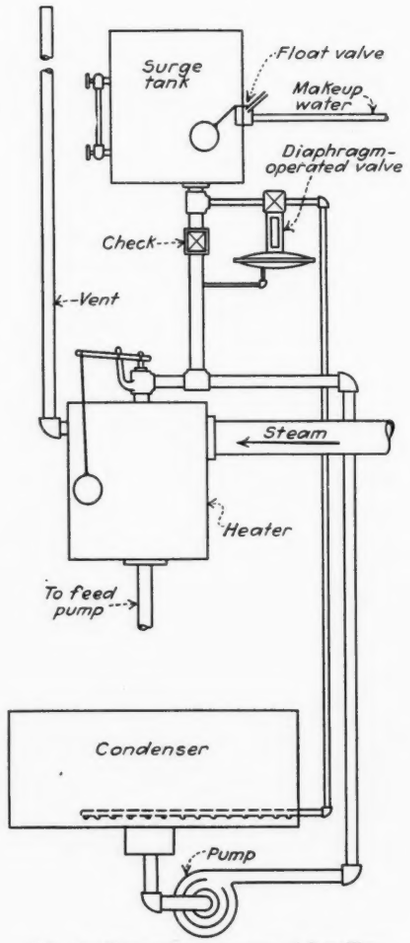


Fig. 2—Albuquerque system of handling condensate and makeup feedwater

Valves

The diaphragm-operated valve is a single-diaphragm, spring-opened type, adjusted to stand open at pressures less than 1 lb. gage on the diaphragm, and to close at pressures of 2 lb. or more. As in the Rawlins system, the arrangement for spraying water into the condenser must be properly designed so that it will admit the maximum makeup water required, and yet not be large enough to overload the condensate pump and flood the condenser. This system may be applied to feedwater entering an open or a closed heater. It is comparatively simple, not having any complicated mechanism and operating entirely with a single diaphragm valve, a check valve and a float-controlled, surge-tank, makeup-water valve.

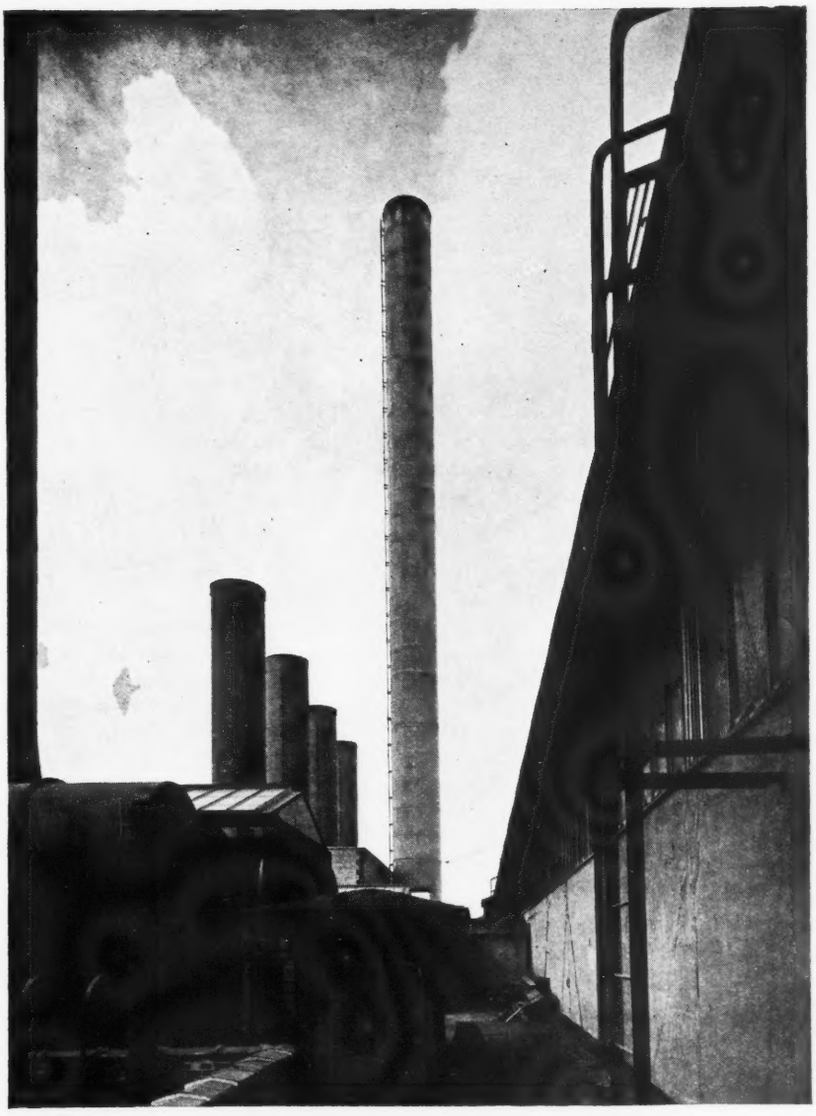


Fig. 1—Erection work completed on new welded stack at Fisk Station

Largest Welded Stack At Fisk Station

Self-supporting, brick-lined, 220-ft. stack uses new type joint which combines shop and field welds for economical construction

IN THE NEW self-supporting, brick-lined, steel stack recently completed for Fisk Station, Chicago, the Commonwealth Edison Company has established a distinct advance in the art of stack building. A new T joint with four welds that balance has been developed. Considerable research and experimentation with the lap joint and other types showed that eccentricity in the pull would develop. A straight pull or push was the objective, and this was obtained in the new T-weld, joining the plates horizontally. Tests have shown joint efficiencies well over 100%. In the test of a section pulled to failure under stress far exceeding that anticipated in service, Fig. 2, the joint tended to open up between the heels of the plates and the rounded portions of the T-ring. The welds showed no sign of failure. Even the vertical joints of the usual type between plate sections, intended mainly for sealing, show efficiencies approximating 75%.

Outside the shell, the T-ring is welded top and bottom to adjoining plates. Inside the shell the plates are welded to either side of the T-leg. The latter extends into the stack to support the brick lining. Holes $\frac{13}{16}$-in. in diameter and spaced on 12-in. centers are drilled in the circular leg of the T. By means of pins inserted in these holes and the use of wedges or cams, the plates are forced into immediate contact with the T-ring for welding.

3-Section Circle

Measuring 13 ft. 10 in. inside the steel, the new stack rises 219 ft. 9 in. above the building roof, 295 ft. above the ground and 300 ft. above city datum. It is made up of $\frac{5}{8}$-in. plate at the breeching section, $\frac{1}{2}$-in. plate for the lower stack and $\frac{3}{8}$-in. plate for the upper 105 ft. 7 in. Plate sections range in height from 5 ft. $5\frac{3}{4}$ in. to 7 ft. $6\frac{1}{2}$ in. Each plate occupies 120 deg. of the circular ring so that there are three plates to the round-about and three vertical joints in each section of the stack.

In the stack there are 124 tons of steel. The brick lining adds 225 tons, so that a total weight of 349 tons rests on the ring-plate girders supporting the structure. The stack sets between and to the rear of the two boilers it serves, with a steel breeching Gunite-lined on either side. The lining is vitreous-shale paving brick set with Portland-cement mortar of 1 to 2 ratio. For the purpose of waterproofing to prevent moisture passing through the lining to the steel shell, approximately one quart of admixture to a bag of cement was added. The latter ingredient, also acting as a retarder, provided a denser and better seal.

Gas Seal

To prevent gas from working its way through the lining to condense on the steel, it was decided to add 1 in. of cement mortar between the lining and the steel. This safeguard should provide a gas-tight seal and prevent condensation.

Beginning at the base, the steel stack was built up section by section. At the top of each plate of a section the two lower welds were made in the shop. The two upper welds on the plates of the section above were made in the field, also the joints between the

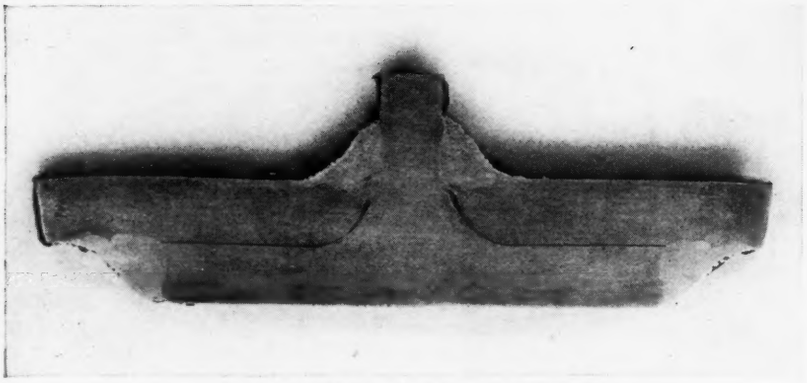


Fig. 2—T-weld after testing to destruction

three sections of the T-ring and the vertical joints between plates to within 1 ft. of the top, as flexibility was needed for fitting. After the section above had been adjusted, the vertical welds were completed. From one section to another, these vertical joints are staggered. A steel ladder with welded rungs is attached to the stack by ½x6-in. base plates welded to the stack and to the ladder uprights.

Welding equipment consisted of three 400-amp. machines spotted on the roof adjacent to the stack. Each machine was grounded to the base of the stack, with only one cable leading to the work above. The working platform, or floating scaffold, was doubly supported by four chain falls secured to the T-ring above and four collapsible safety legs pressing on the T-ring below. Plates were raised by a derrick on this platform. Protection for the welders against the wind was afforded by sheet-metal cages hanging outside the shell. Mild-steel slag-shielded rods were used.

To protect the stack, plates were painted with blue lead in the shops except where the plates were to be welded. Aluminum paint over the welds and then blue lead served to protect the black-graphite paint which will be applied to the outer shell.

*Statistics on the ½-in. and ⅜-in. plates show that it required 0.132 kw.hr. per ft. of 2-pass welding. Per man-welding-hour the current consumption averaged 0.709 kw.hr. The lineal feet of 2-pass welding per hour averaged 5.36. In the steel work, about 7 hr. was required for welding to 3 hr. for erection. Record time was made in the building. Field erection started April 17, and the stack with lining was completed July 29.

Comment by construction executives of the operating company, Graham, Anderson, Probst & White, architects, and the consulting engineers, Sargent & Lundy, indicate that a welded stack of the type described is more rigid and durable than a riveted stack. Leaky seams and caulking are avoided, so that maintenance expense should be low. The unusual precautions against corrosion should add many years to the life of the stack. That it proved more economical to build is credited to the design of details and careful planning in shop and field by the contractor and builder.

Incidentally, it will be of interest to know that the stack is to serve the new 30,000-kw. high-pressure "topping" unit now being erected and soon ready for operation, combined with two existing units of 60,000 kw.

* Inspection was visual by an independent engineering laboratory.

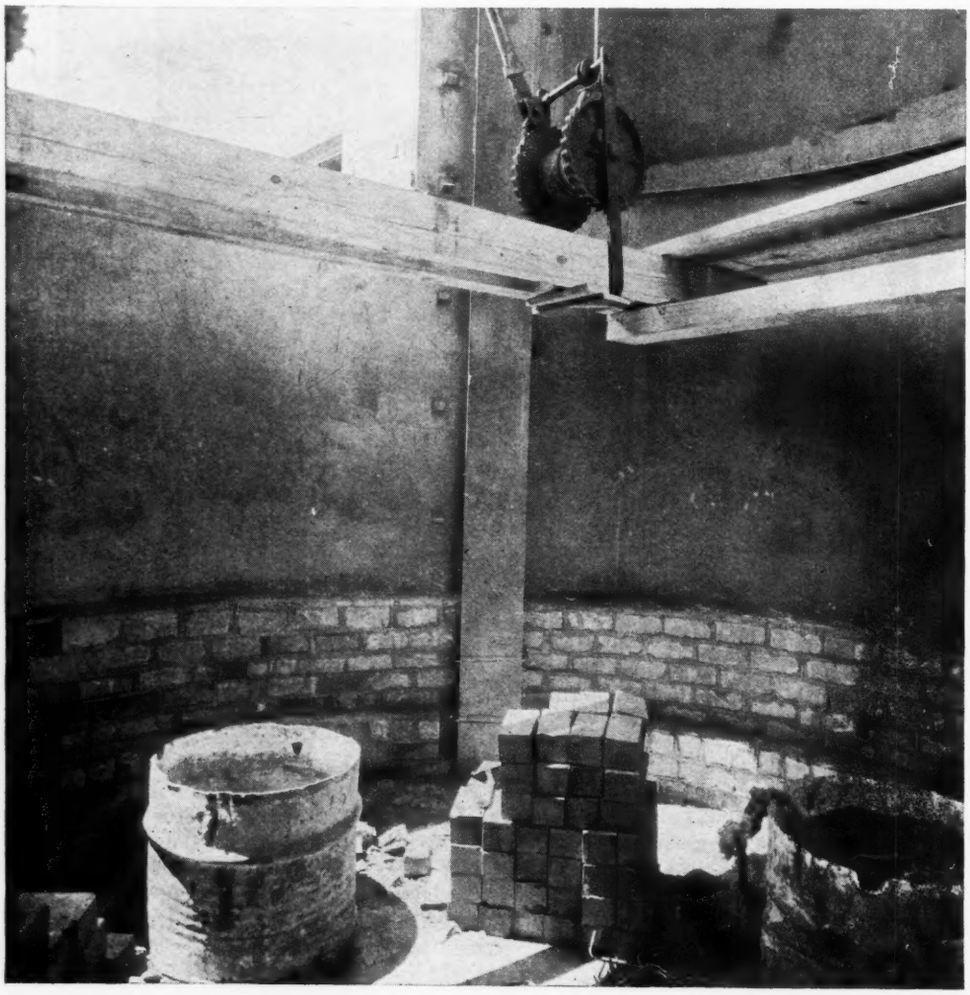


Fig. 3—Brick lining under way

Solid Gasoline

DR. ADOLPH PRUSSIN, of New York, has succeeded in "solidifying" gasoline to increase its factor of safety, especially for aviation. Fuel produced by Dr. Prussin is a reddish paste, and has been tested in a single-cylinder engine that functioned as well when driven with the jellied as with the liquid gasoline. To determine the explosibility of the solid fuel, four incendiary bullets were fired into a 5-gal. can of it with an army rifle at a range of 25 ft. Nothing happened after the first three shots, but the fourth bullet ignited the gasoline, and then only because some of it had been liquefied and spilled on the ground.—*Compressed Air Magazine.*

The metal-spray gun set up inside the cylinder. The 46-in. dia. x 53 in. long cylinder was set up on rollers at the end of a lathe bed so it could be rotated while the spray gun, mounted on a toolpost extension, was fed in and out

Metal Spray Relines Cylinder

When the copper-plated interior of a 46-in. penstock-valve operating cylinder failed, 280 lb. of sprayed bronze was applied and subjected to service at over 1,000 lb. water pressure

By J. C. Gaylord

Hydro Engineer, Southern California Edison Co., Ltd., Los Angeles, Calif.

AT BIG CREEK No. 2A power house of Southern California Edison Co., there are four 34-in. lower penstock valves, of special design to operate at slightly over 1,000 lb. per sq. in. internal pressure. The operating cylinder on each is cast steel, 46 in. inside diameter by 53 in. long, with 3½-in. walls. On one end is a 59-in. flange, on the other a 65-in., making total weight about 6½ tons. After nine years, the copper plating inside one of the four, imperfectly formed originally, showed such serious wear that it was decided to metal-spray in a new bronze lining.

The cylinder was set up on a boring mill in Power House No. 3, so that corroded metal and roughness could be turned off and flange faces resquared. A slight shoulder was left at each end to avoid a feather edge of sprayed metal. Then a fine thread of about $\frac{1}{8}$-in. pitch and $\frac{1}{32}$-in. deep was cut with a blunt-nosed tool all across the inside, giving a rough ridged surface from which the metal had actually been torn away and providing an excellent base for sprayed metal. Before final "threading," spots of porous metal discovered in turning were heated individually with a torch to drive out moisture forced into them due to the high operating pressure, then the whole cylinder was warmed with a 5-kw. heater inside for 12 hr.

To assure a uniform layer of sprayed metal, it is necessary to rotate the piece while the gun is moved back and forth at an even rate. Therefore the cylinder was set up with two flanged rollers under each flange, three rollers turning freely and the fourth keyed to a driven shaft powered by a drive for a Toledo thread-cutting machine. All roller bearings were welded to the same steel plate to preserve alignment. This entire assembly was then placed at the end of a lathe bed and the cylinder aligned with the bed so that a spray gun mounted on an angle extension on the lathe carriage could be fed in and out uniformly as the cylinder was rotated. The gun nozzle was set about 5 in. away from the surface to be sprayed.

This entire set-up worked admirably, except that flanges on the driving roller were broken off after several hours of operation, forcing a shutdown for replacement. This was apparently caused by end thrust created by the coarse-thread, small-depth machining on the face of the cylinder flange. This facing should have been finer, or the "thread" on one flange should have been opposite to that on the other.

The metal-spray gun itself was a Model 126 Universal made by the Metalspray Company of Los Angeles. Oxygen pressure was 17 lb., acetylene 15, and about 1,905 cu. ft. of oxygen were used to 1,017 cu. ft. of acetylene. Air, supplied by the station compressor, was maintained at 60 lb. and filtered to take out entrained moisture or oil that might affect metal being deposited. The surface was sprayed as soon as possible after turning to avoid oxidation. No. 12 B & S gage Chase phosphor-bronze spring wire was sprayed. Cylinder speed was 4 r.p.m., gun feed about $\frac{3}{32}$ in. per revolution, requiring 90 min. spraying time for each layer of deposited metal. Total net spraying time was 30 hr., requiring 280 lb. of wire.

Initial inside diameter was just over 46 in., and cleaning-up cuts before the "threading" increased this to 46.1 in. Spraying reduced the diameter to 45.880 in. (indicating an 0.11-in. sprayed coat), which was then turned and ground to 46.0 in. The finished surface appeared in very good condition, and maximum end-to-end variation was less than 0.001 in. Costs, as indicated, were quite reasonable.

Speaking of Power

THIS MONTH you will receive two copies of *Power,* this regular September number and the extra mid-September "Modern Plant Number." Let me tell you what mid-September will contain, and why . . . After the long lull of depression years, new and revamped power plants are springing up all over the country. Their designs don't start where we left off in 1929, not by a long shot, because creative thinking and technical development went right on during the lean years, when practically no money could be had for construction. . . . Revolutionary advances in equipment and hook-up have created an insistent reader demand for a summary of today's latest designs, including many not yet in operation. Mid-September number will be a "Modern Plant" number, exclusively, so that engineers everywhere may check their own power planning by the best modern practice. . . . For more than two months two editors have been working steadily on the single task of gathering and tabulating extensive design data on 350 plants. Every plant tabulated will be truly modern; no installation operating before January 1, 1936, will be included.

. . . . the lean years

But this Modern Plant Number will do far more than tabulate. It will pick out 18 outstanding plants—central stations, industrials and institutions—for concise description in two or three pages each. Each article will include a large-scale cross-section of the boiler unit, a flow diagram, and a table of equipment. . . . We boost this Modern Plant Number with good conscience, not because it represents a heavy expenditure of editorial time and money, but because it performs a service absolutely needed by the field at this time.

My editorial, "Drought Warning," page 479, tells what the phenomenal growth of air conditioning is doing to city water and sewage systems. The situation is serious and will soon force most large conditioning systems to use cooling towers or to cool coils directly with air. It's safe to predict a big boom in cooling towers, including the outdoor type. . . . To see why such things happen, let's consider what the public is doing to air conditioning and what air conditioning does to water: The number of air-conditioning installations in the United States has increased 1400% since 1933, according to the Department of Commerce. They estimate that 40% of all these installations cool directly with city water—take the water out of the public main and dump it back into the public sewer. . . . Without a cooling tower every bit of this water is paid for and then wasted. With a cooling tower, all but a "drop in the bucket" (the portion evaporated) goes round and round. Every pound of water *paid for* carries a heat load of around 1,000 B.t.u. In this matter of water waste, the difference between the various systems is the difference between black and white, between using a canal to float a peanut or to carry a barge. . . . Some propose to make water waste nobody else's business by using private wells. Fair enough, but what about public sewage systems overloaded with the discharge? The really private system would have to pipe the water out of the river and pipe it all the way back again. How many would do that?

. . . . drop in the bucket

Waterside Station (Consolidated Edison, New York) bridges the whole span of power history from the steam engines of 1900 to generation by today's high-pressure "top" at 1,400 lb. and 900 F. Right up to 1936, one of the two boiler houses contained 92 boilers. They are going out; eight modern units will take their place to generate far more steam at tremendously higher pressure and temperature. . . . To modernize an old plant such as this you have to solve many knotty problems. For example, the high-pressure steam will be carried 200 ft. across the street to the low-pressure turbines. These, in turn, will send their condensate back to feed the new boilers. . . . Located close to important residential and business districts, Waterside will go the limit in smoke and dust prevention, with practically smokeless combustion, electrostatic precipitation and a stack rising 450 ft. above street level. . . . . The general description of this plant will appear in mid-September *Power,* along with those of 17 other outstanding plants. The article on page 480 of the present number concentrates on a single phase of Waterside's new construction, the welding of piping. . . . Most readers will recall that central stations in general were not quick to adopt welding for high-pressure steam lines. But times have changed; the pioneer work done by boiler manufacturers and welding experts, and their successful efforts to meet the stringent demands of the Boiler Code Committee have had useful by-products. Today we weld not only the large drums of high-pressure boilers, but also steam lines for any pressure and temperature. . . . The Waterside welding article tells in detail how the joints are stress-relieved and X-rayed on the job.

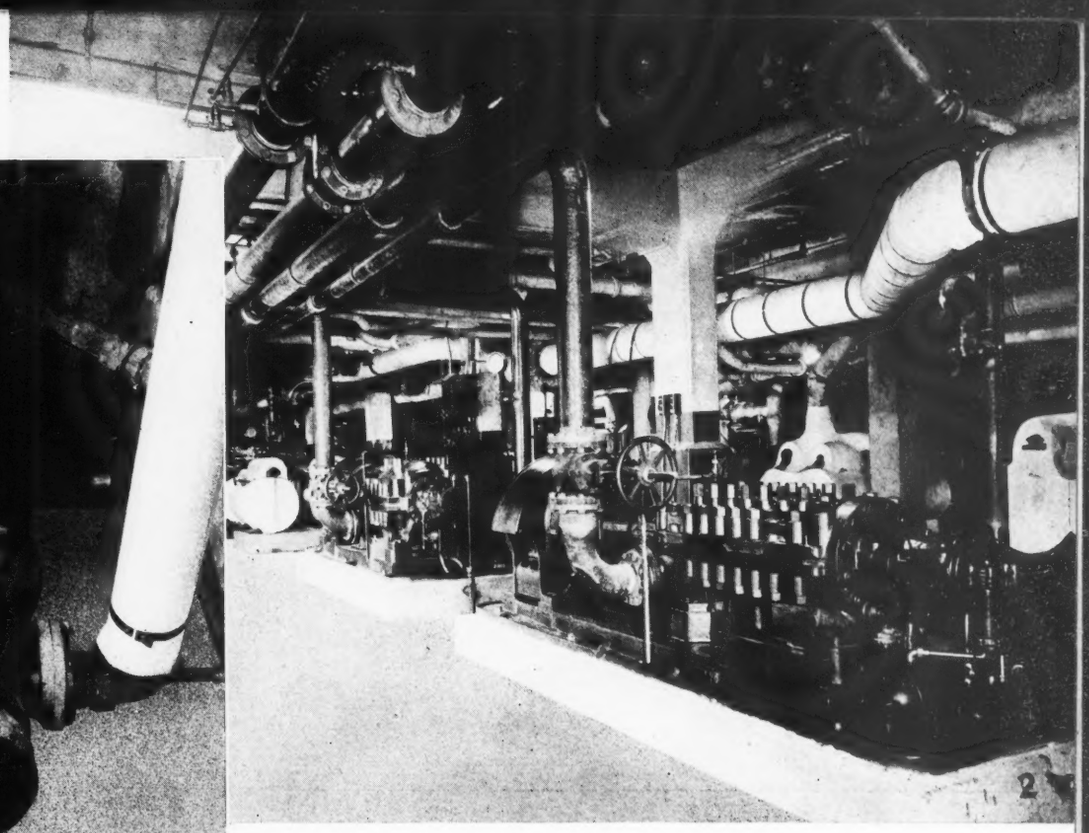
. . . . knotty problems

. . . . smoke prevention

When the sun is shining, they say, is the time to think about fixing the leaks in the roof. Otherwise, one is always in the position of the irresponsible farmer who could never fix his roof; it didn't need fixing when the sun was shining, and he couldn't get at it when it was raining. . . . The moral (and we faintly recall having harped on this string before) is that now, while the weather is hot, is the time to start doing something about the heating plant. The whole system should be overhauled and put in A-1 operating shape before the heating season sets in.

. . . . irresponsible farmer

PHIL SWAIN
Editor



Photographs courtesy Ingersoll-Rand Co.

FORCE FEEDING

1

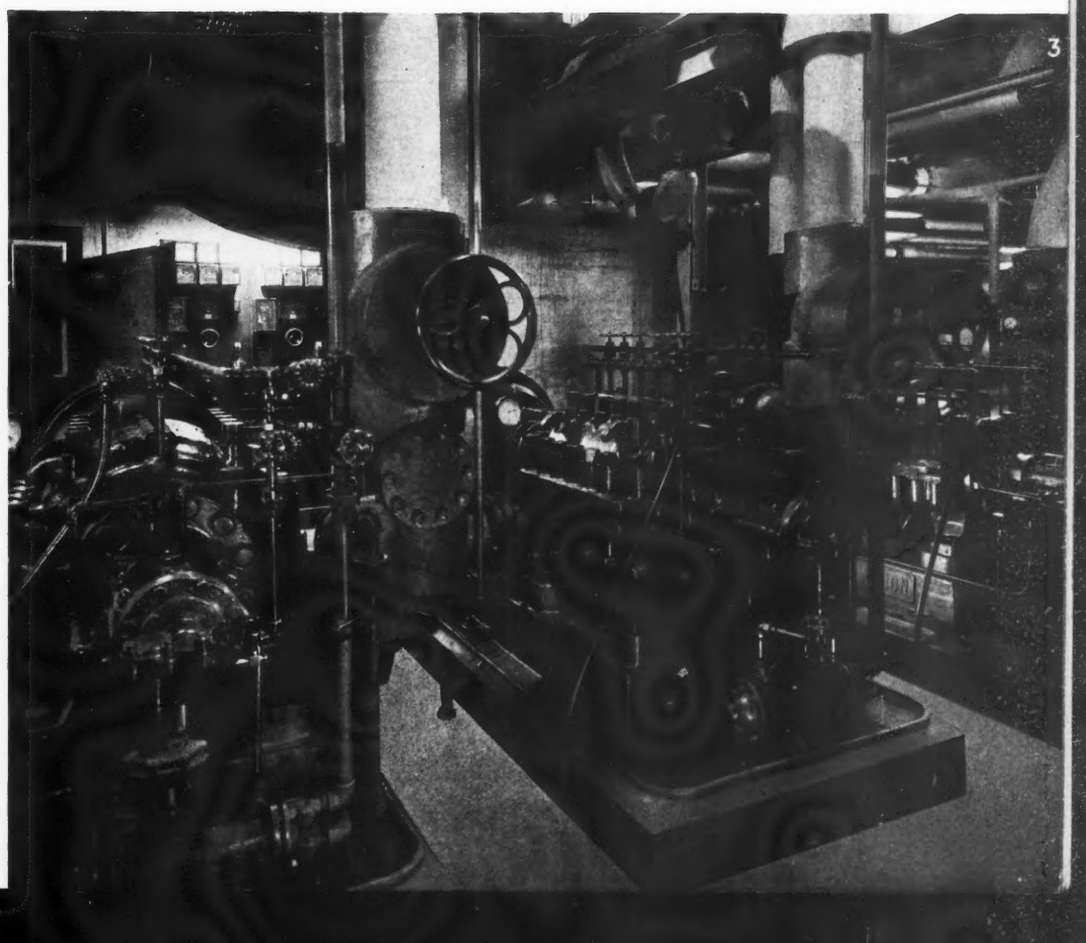
In Frenchtown, N. J., Frenchtown Porcelain Co. handles boiler-feed service with a motorpump at 320-ft. head

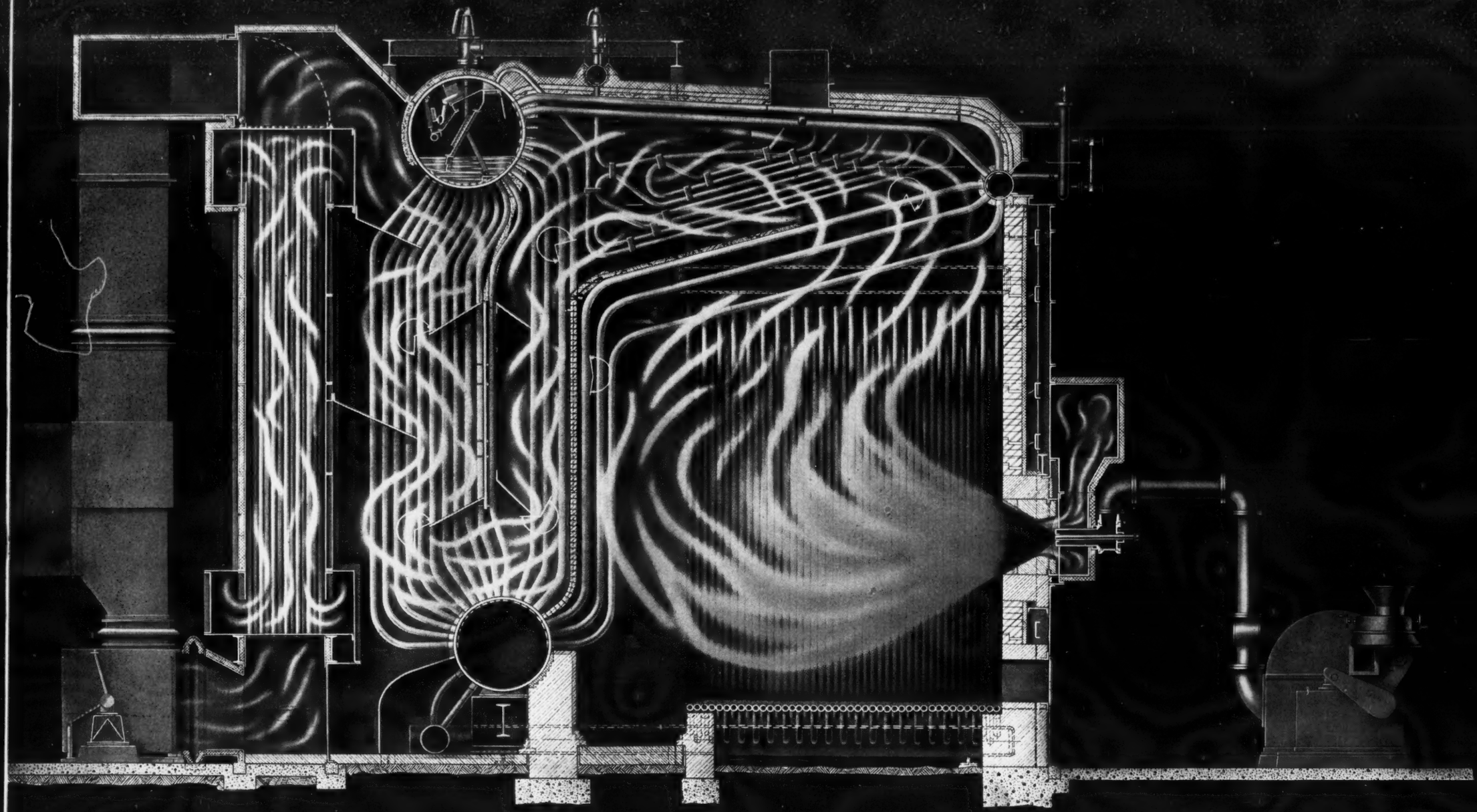
2

In "Tire Town," Akron, Ohio, boiler-feed at the new high-pressure plant of Firestone Tire & Rubber Co., requires an 8-stage Cameron pump (right)

3

In "Chocolate Town," Hershey, Pa., Hershey Chocolate Co., uses three feed pumps, the first a 550-g.p.m. unit operating against 1260-ft. head and driven by a 252-hp. Terry turbine, the other two 365-g.p.m. units operating against 1260-ft. head and driven by 1200-hp. G.E. synchronous motors





THE NEW RILEY TYPE "RP" BOILER UNIT

MOST MODERN OF STEAM GENERATING UNITS

MOST MODERN OF STEAM GENERATING UNITS

for steam capacities from 20,000 to 150,000 pounds per hour

These distinctive advantages explain the rapid SWING to RILEY TYPE "RP" UNITS

HIGH EFFICIENCY

High efficiency results from rapid positive circulation, cross flow of gases over heating surface, large area of tube surface exposed to radiant heat, low flue gas temperatures, proper arrangement of baffles and proper co-ordination of boiler and fuel burning equipment.

RAPID POSITIVE CIRCULATION

The design of the Riley Type "RP" Boiler is based on the ring flow unidirectional principle of circulation. The great distance between upper and lower drum results in a large flow-producing head.

CROSS FLOW OF GASES

Riley Type "RP" Boilers are baffled so as to give cross flow to gases over the boiler heating surface, resulting in high heat transfer rates.

LOW MAINTENANCE

Rapid positive circulation assures a minimum of boiler maintenance. The use of close spaced water walls eliminates refractory maintenance.

DRY STEAM

Steam delivered to the upper drum enters above the water line which, together with the efficient Riley Steam Separator, assures dry steam at all ratings.

EXTREME LOAD FLUCTUATIONS

Extreme load fluctuations are easily carried with Riley Type "RP" Units because of the large amount of tube area exposed to radiant heat and rapid boiler circulation.

CLOSE SPACED WATER WALLS AND FLOORS

3¼" tubes on 3⅜" centers, presenting practically a solid water wall surface, are used in the side walls and floors.

LOW FLUE GAS TEMPERATURES

The use of 2½" O. D. tubes in the last tube bank makes possible a large amount of heating surface which, together with rapid circulation and cross flow of gases, assure unusually low flue gas temperatures.

ASH EASILY REMOVED

When Riley "RP" Units are fired with pulverized coal, granular ash is formed. This ash can be easily blown with air or steam lance to the ash pit at the rear of furnace where it is easily removed.

ADAPTABLE TO LIMITED SPACE

Riley Type "RP" Units are adaptable to existing boiler houses where space, especially height, is severely restricted.

A FEW REPRESENTATIVE USERS OF RILEY "RP" UNITS

Guide Lamp Co., General Motors Corp., Anderson, Ind.
1-50,000 - 275 lbs. - 577° F
Bemis Bag Co., Peoria, Ill., 1-70,000 - 275 lbs. - 600° F
Newport Electric Co., Newport, R. I.
2-60,000 - 275 lbs. - 765° F
Utilities Pr. & Lt. Operating Co., Engrs.
General Aniline Co., Rensselaer, N. Y.
1-80,000 - 250 lbs. - 475° F
Riverside Metal Co., Riverside, N. J.
1-65,000 - 450 lbs. - 516° F
Wheeling Steel Co., Wheeling, W. Va.
C. W. E. Clark, Engrs., 1-100,000 - 660 lbs. - 650° F
Central Ohio Pr. & Lt. Co., Findlay, Ohio
Sargent & Lundy, Engrs., 2-60,000 - 450 lbs. - 825° F
Hartford City Paper Co., Hartford City, Ind.
A. B. Kinney, Engrs., 1-55,000 - 350 lbs. - 600° F
Lewiston Bleachery, Lewiston, Me., F. P. Sheldon & Sons
Chas. T. Main, Engrs., 1-70,000 - 450 lbs. - 660° F
Hellwig Silk Dyeing Co., Philadelphia, Pa.
J. G. Berger, Engr., 1-100,000 - 475 lbs.
Great Lakes Steel Corp., Ecorse, Mich.
2-75,000 - 450 lbs. - 700° F
Natrona Power & Light Co., Natrona, Pa.
1-90,000 - 450 lbs. - 750° F
S. J. Brisban Co., Colombia, S. America
1-36,000 - 425 lbs. - 650° F.
Winchester Repeating Arms Co., New Haven, Conn.
Arthur L. Nelson, Cons. Engr., 2-75,000 - 725 lbs. - 750° F
Western Cartridge Co., E. Alton, Ill.
Arthur L. Nelson, Cons. Engr., 2-75,000 - 725 lbs. - 750° F
American Bridge Co., Trenton, N. J.
Ford Bacon & Davis, Engrs., 2-35,000 - 275 lbs.
Port Huron Sulphite & Paper Co., Port Huron, Mich.
1-80,000 - 675 lbs. - 710° F
Barrett Co., Frankfort, Philadelphia, Pa.
1-80,000 - 450 lbs. - 500° F

The satisfactory performance of existing installations has definitely proven the correctness of design of Riley "RP" Units. In justice to yourself and your company you should thoroughly investigate Riley Type "RP" Boiler Units.

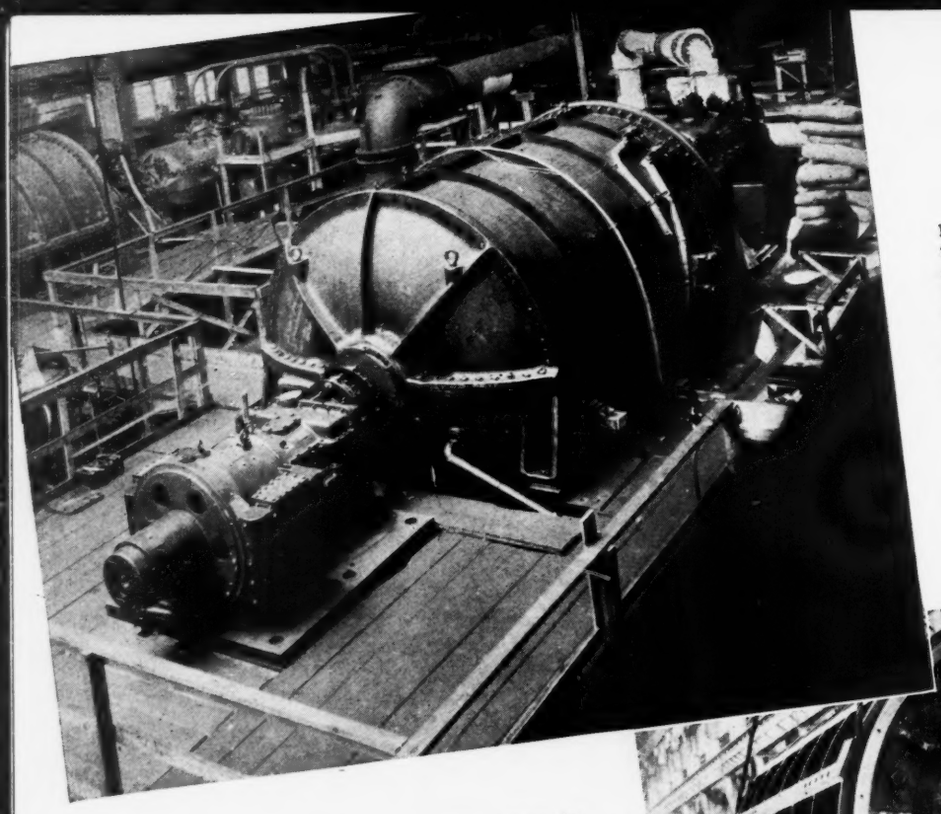
RILEY

STOKER CORPORATION
WORCESTER, MASSACHUSETTS

COMPLETE STEAM GENERATING UNITS

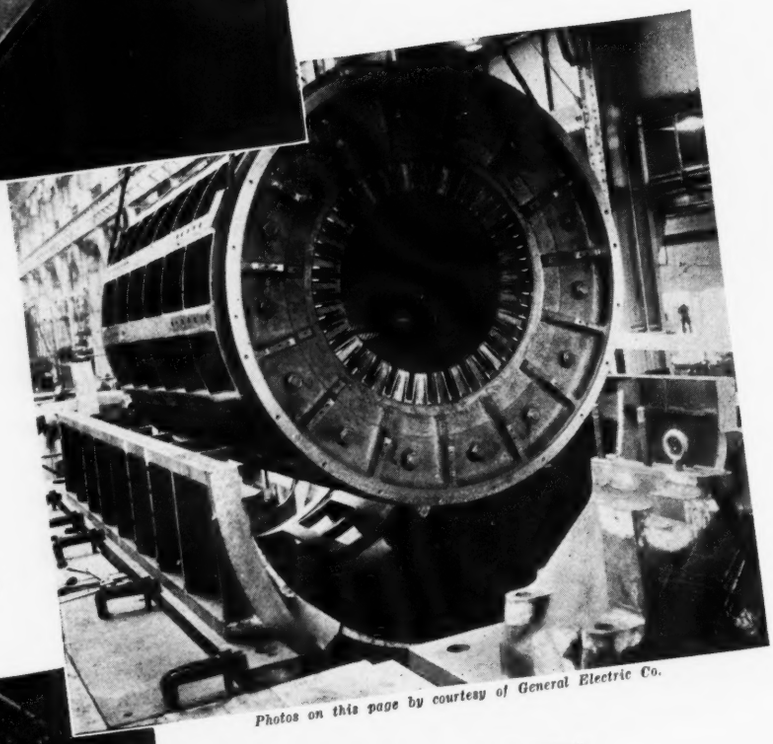
BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS
PULVERIZERS - BURNERS - STOKERS - WATER-COOLED FURNACES
STEEL-CLAD SETTINGS

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta



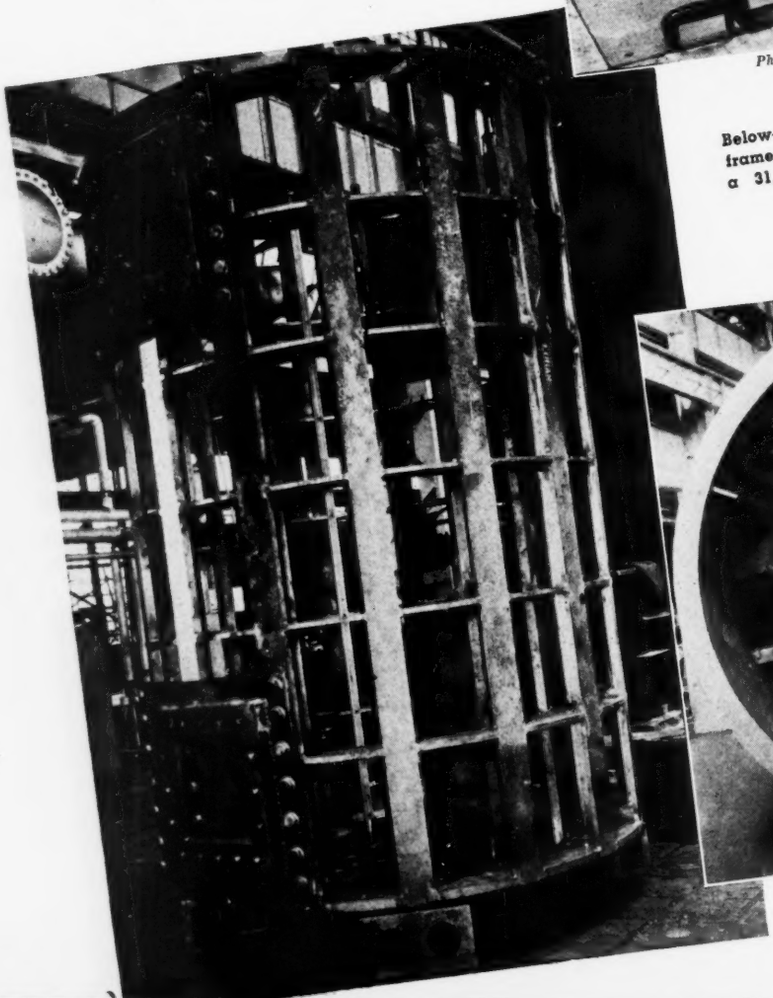
Left—31,250-kva., 0.80-p.f., 12,000-volt, 3,600-r.p.m. hydrogen-cooled turbine-generator under test for the Millers Ford station of the Dayton Power & Light Co. Connected to the near end of the generator is the direct-connected, geared, self-cooled exciter without its housing

Right—Unwound stationary armature for a 50,000-kva., 3,600-r.p.m. hydrogen-cooled turbine-generator being lowered into one-half of its outer frame

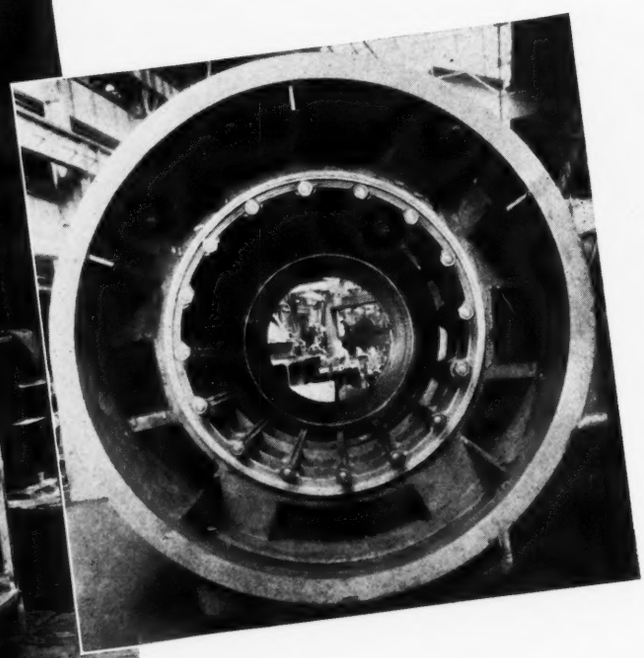


Below—Inner or stationary frame into which the laminated core is stacked for a 50,000-kva., 3,600-r.p.m. turbine-generator

Photos on this page by courtesy of General Electric Co.



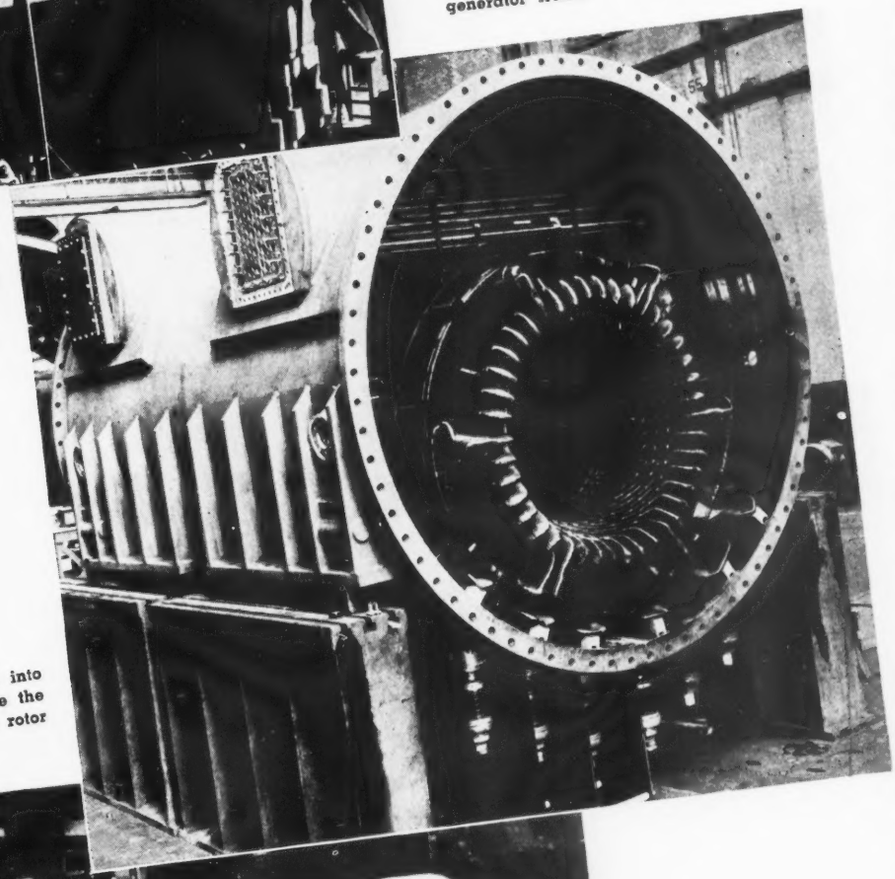
Below—End view of stationary armature frame ready for stacking laminated core for a 31,500-kva. hydrogen-cooled generator



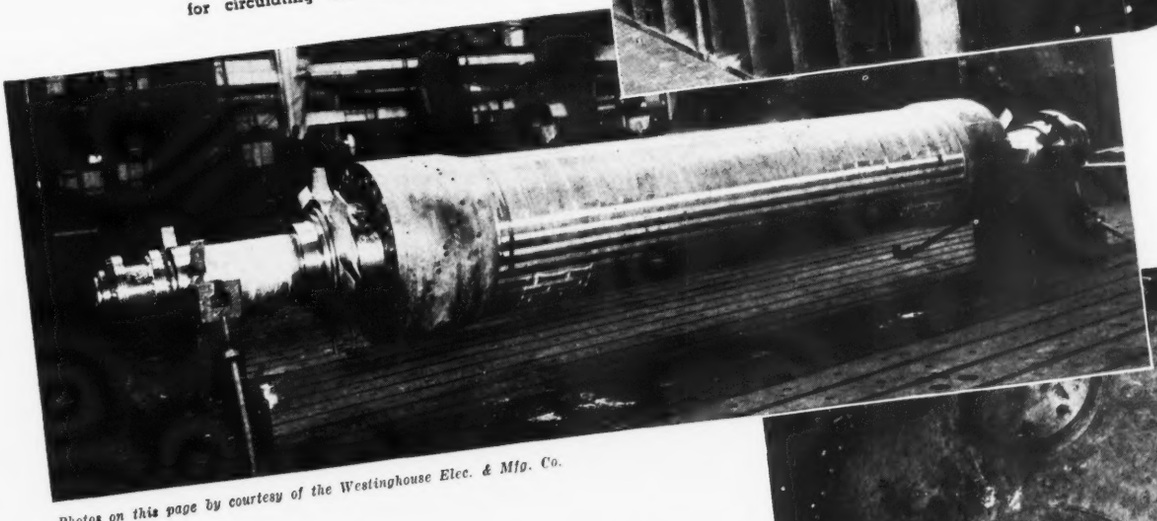
3600 R.P.M. Requires Hydrogen Cooling

Left—A 58,888-kva., 0.90-p.f., 3,600-r.p.m. hydrogen-cooled turbine-generator being tested at full load for temperature rise in the manufacturer's shops. This unit is being installed in the Waterside plant of the Consolidated Edison Co., New York, N. Y.

Below—Wound stator of a 43,750-kva., 0.80-p.f., 3,600-r.p.m. hydrogen-cooled turbine-generator to be installed in the West End station of the Cincinnati Gas & Electric Co., Cincinnati Ohio. The hydrogen coolers are shown installed in the top of the generator frame



Below—This speedy looking rotor goes into the generator stator on the right. Note the air-foil-type blower at each end of the rotor for circulating the hydrogen



Photos on this page by courtesy of the Westinghouse Elec. & Mfg. Co.

Right—Two end domes of the West End generator casing fastened together preparatory to testing

CAN YOU ANSWER

1. What effect does air mixed with steam have in reducing the temperature of steam heated equipment?

2. How should storage type hot water heaters be hooked up to eliminate the danger of water hammer damaging the tubes?

3. When is a steam trap not a steam trap? (Clue: What uses do Armstrong Traps have, other than discharging condensate?)

4. What size trap should be used for a "fast break" on a 36 inch jacketed kettle operating on 60 lb. steam pressure?

You can find the answers in

ASK for your copy of The Armstrong Steam Trap Book—a 32 page manual of useful information about steam, condensate drainage, traps, etc. It answers dozens of common questions and gives detailed information about Armstrong Traps for every purpose. *Free on request.* ARMSTRONG MACHINE WORKS, 812 Maple St., Three Rivers, Mich.

ARMSTRONG TRADE MARK "INVERTED BUCKET" STEAM TRAP

ARMSTRONG

THESE QUESTIONS?

5. What frequently retards proper heating of horizontal pipe coils and what is the cure?
6. What simple precaution should be taken to protect unit heater tubes for corrosion?
7. What size pipe should be used for a return header handling 2000 pounds of condensate per hour?
8. What factor of safety should be used in selecting a trap to drain a steam separator?

this book:

KEY:

YOU can find the answers to the accompanying questions on the following pages of the new fourth edition of The Armstrong Steam Trap Book:

Question No. 1. . . . Page 3
Question No. 2. . . Page 19
Question No. 3. . Page 28-29
Question No. 4. . Page 23
Question No. 5. . Page 18
Question No. 6. Page 20
Question No. 7. Page 24
Question No. 8. Page 15

STEAM TRAPS

Wire and Fuse Sizes for Motor Branch Circuits

Full-load current rating of motor	Minimum allowable size of copper wire, Am. gage or cir. mils.			For Running Protection of Motors		Maximum Allowable Rating of Branch Circuit Fuses		
				Max. rating of N.E.C. fuses	Max. setting of time-limit protective device	Squirrel-cage & synchronous (full-voltage, reactor and resistor starting.) Single phase	Squirrel-cage & synchronous (auto-transformer starting.) High reactance squirrel-cage	Wound rotor a.c. and d.c.
Amperes	Rubber	Vanished Cambric	Slow Burning	Amperes	Amperes	Amperes	Amperes	Amperes
1	14	14	14	2*	1.25**	15	15	15
2	14	14	14	3*	2.50**	15	15	15
3	14	14	14	4*	3.75**	15	15	15
4	14	14	14	6*	5.0 **	15	15	15
5	14	14	14	8*	6.25**	15	15	15
6	14	14	14	8*	7.50**	20	15	15
7	14	14	14	10*	8.75**	25	20	15
8	14	14	14	10*	10.0 **	25	20	15
9	14	14	14	12*	11.25**	30	25	15
10	14	14	14	15*	12.50**	30	25	15
11	14	14	14	15*	13.75**	35	30	20
12	14	14	14	15	15.00	40	30	20
13	12	14	14	20	16.25	40	35	20
14	12	14	14	20	17.50	45	35	25
15	12	12	14	20	18.75	45	40	25
16	12	12	14	20	20.00	50	40	25
17	10	12	12	25	21.25	60	45	30
18	10	12	12	25	22.50	60	45	30
19	10	12	12	25	23.75	60	50	30
20	10	12	12	25	25.0	60	50	30
22	8	10	10	30	27.50	70	60	35
24	8	10	10	30	30.00	80	60	40
26	8	8	8	35	32.50	80	70	40
28	8	8	8	35	35.00	90	70	45
30	6	8	8	40	37.50	90	70	45
32	6	8	8	40	40.00	100	70	50
34	6	6	8	45	42.50	110	70	60
36	6	6	8	45	45.00	110	80	60
38	6	6	8	50	47.50	125	80	60
40	6	6	8	50	50.00	125	80	60
42	5	6	6	50	52.50	125	90	70
44	5	6	6	60	55.0	125	90	70
46	4	6	6	60	57.50	150	100	70
48	4	6	6	60	60.0	150	100	80
50	4	5	6	60	62.50	150	100	80
52	4	5	6	70	65.0	175	110	80
54	4	4	6	70	67.50	175	110	90
56	4	4	6	70	70.00	175	120	90
58	3	4	5	70	72.50	175	120	90
60	3	4	5	80	75.00	200	120	90
62	3	4	5	80	77.50	200	125	100
64	3	4	5	80	80.00	200	150	100
66	2	4	4	80	82.50	200	150	100
68	2	4	4	90	85.00	225	150	110
70	2	3	4	90	87.50	225	150	110
72	2	3	4	90	90.00	225	150	110
74	1	3	3	90	92.50	225	150	125
76	1	3	3	100	95.00	250	175	125
78	1	2	3	100	97.50	250	175	125
80	1	2	3	100	100.00	250	175	125
82	0	2	2	110	102.50	250	175	125
84	0	2	2	110	105.00	250	175	150
86	0	2	2	110	107.50	300	175	150
88	0	2	2	110	110.00	300	200	150
90	0	1	2	110	112.50	300	200	150
92	0	1	2	125	115 00	300	200	150
94	0	1	2	125	117.50	300	200	150
96	0	1	2	125	120.00	300	200	150
98	0	0	2	125	122.50	300	200	150
100	0	0	2	125	125.00	300	200	150
105	00	0	1	150	131.5	350	225	175
110	00	0	1	150	137.5	350	225	175
115	00	0	1	150	144.0	350	250	175
120	00	0	1	150	150.0	400	250	200
125	000	00	0	175	156.5	400	250	200
130	000	00	0	175	162.5	400	300	200
135	000	00	0	175	169.0	450	300	225
140	000	00	0	175	175.0	450	300	225
145	200,000	000	0	200	181.5	450	300	225
150	200,000	000	0	200	187.5	450	300	225
155	200,000	000	0	200	194.0	500	350	250
160	200,000	000	0	200	200.0	500	350	250
165	0000	000	00	225	206.	500	350	250
170	0000	200,000	00	225	213.	500	350	300
175	0000	200,000	00	225	219.	600	350	300
180	0000	200,000	00	225	225.	600	400	300
185	250,000	200,000	000	250	231.	600	400	300
190	250,000	200,000	000	250	238.	600	400	300
195	250,000	0000	000	250	244.	600	400	300
200	250,000	0000	000	250	250.	600	400	300
210	300,000	0000	000	250	263.	—	450	350
220	300,000	250,000	000	300	275.	—	450	350
230	350,000	250,000	200,000	300	288.	—	500	350
240	350,000	250,000	200,000	300	300.	—	500	400
250	400,000	300,000	0000	300	313.	—	500	400
260	400,000	300,000	0000	350	325.	—	600	400
270	500,000	350,000	250,000	350	338.	—	600	450
280	500,000	350,000	250,000	350	350.	—	600	450
290	500,000	350,000	300,000	350	363.	—	600	450
300	500,000	400,000	300,000	400	375.	—	600	450
320	500,000	500,000	300,000	400	400.	—	—	500
340	600,000	500,000	350,000	450	425.	—	—	600
360	600,000	500,000	350,000	450	450.	—	—	600
380	700,000	500,000	400,000	500	475.	—	—	600
400	700,000	600,000	400,000	500	500.	—	—	600
420	800,000	600,000	500,000	600	525.	—	—	—
440	800,000	700,000	500,000	600	550.	—	—	—
460	900,000	700,000	500,000	600	575.	—	—	—
480	900,000	700,000	500,000	600	600.	—	—	—
500	1,000,000	800,000	600,000	—	625.	—	—	—
520	1,000,000	800,000	600,000	—	650.	—	—	—
540	1,100,000	900,000	600,000	—	675.	—	—	—
560	1,200,000	900,000	700,000	—	700.	—	—	—
580	1,200,000	1,000,000	700,000	—	725.	—	—	—
600	1,300,000	1,000,000	700,000	—	750.	—	—	—
625	1,400,000	1,000,000	800,000	—	782.	—	—	—

* From the National Electrical Code by American Standards Association.

** The maximum rating of fuses and thermal cut-outs, and the maximum setting of over-current units on circuit breakers or controllers, when used as motor-running protective devices shall be 125% of the motor full-load current. Where the values given in running-protection columns do not correspond to the standard sizes of ratings of thermal cut-outs and thermal relays, the next higher standard size or rating may be used.

EXAMPLE: Full-load current of a 440-volt, 15-hp., 3-phase motor is 19 amp. per terminal. Find 19 amp. in left-hand column and follow to right for wire size, which is No. 10 for rubber covered and No. 12 for other insulations. Running fuses have 25-amp. rating and protective relay setting 23.75 amp. If motor is started on full voltage, 60-amp. fuses are allowed; for reduced-voltage starting 50-amp. fuse and for a wound-rotor motor only 30-amp. fuse are permitted on the branch circuit supplying the motor.

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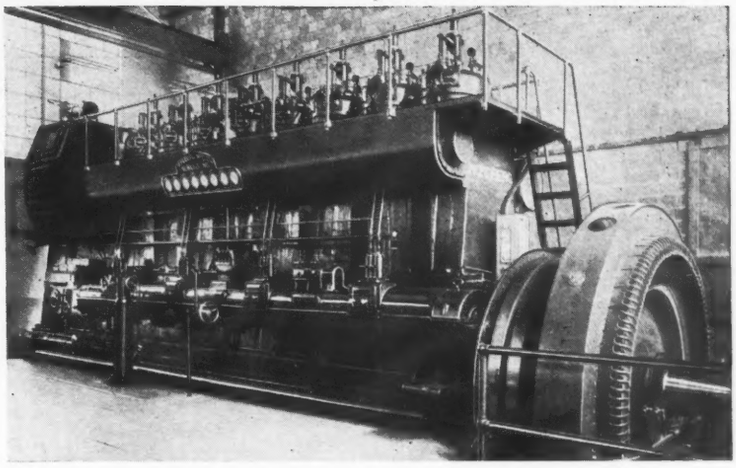


Fig. 1—Lubbock has long had a diesel municipal plant. Early small engines were replaced by a 1250- and a 1500-hp., 2-cycle, air-injection, Nordberg, crosshead-type diesels. In Sept., 1936, this 1500-hp. unit was added to meet increasing load, but a low gas price favored gas instead of oil for primary fuel

Gas-Fired Diesel

MANY ATTEMPTS have been made to burn gas in a 4-cycle diesel, but they always ended in the realization that conversion was necessary to reduce compression ratio. This meant changes of pistons, heads or connecting rods, and addition of electric ignition, and required from several hours to several days. Even then the engine was a compromise, built to withstand diesel temperatures and pressures and operating on the Otto cycle at lower efficiency. But an engine that is readily convertible is needed in areas where gas is cheap.

For the past year a full diesel burning gas as fuel has been operating in the municipal plant at Lubbock, Tex. It is an 8-cyl., 1,500-hp., 2-cycle, Nordberg, crosshead engine of the air-injection type. When operating on gas, the 3-stage injection-air compressor compresses gas instead. At 1100 lb. it is discharged into a common line from which it is admitted to individual cylinders through fuel-injection nozzles equipped with variable-lift needle valves, Fig. 2.

No major change is made in the cylinder for conversion, either fuel using the same pistons, cylinder head, injection nozzles, etc. Compression pressure is 475 lb., and gas is injected through the regular fuel-injection valve, to be ignited from the heat of compression in the normal way. Exhaust is through ports. To obtain smooth operation and uniform combustion, some sort of combustion stabilizer is necessary. Therefore, a small amount of fuel oil is injected with the gas as "pilot oil."

Each cylinder has an individual Bosch fuel-oil pump. When operating on gas, the pump is connected to operate a fuel-valve actuator, pumping lubricating oil instead of fuel oil. The hydraulic valve-actuator plunger is connected to the injection-valve lever, which lifts the needle valve. The Bosch pump, in turn, is connected to the governor in the usual way. Any change in load sends more or less oil to the actuating plunger, which in turn varies lift of the needle valve. A water jacket on the oil line from pump to actuator maintains oil temperature.

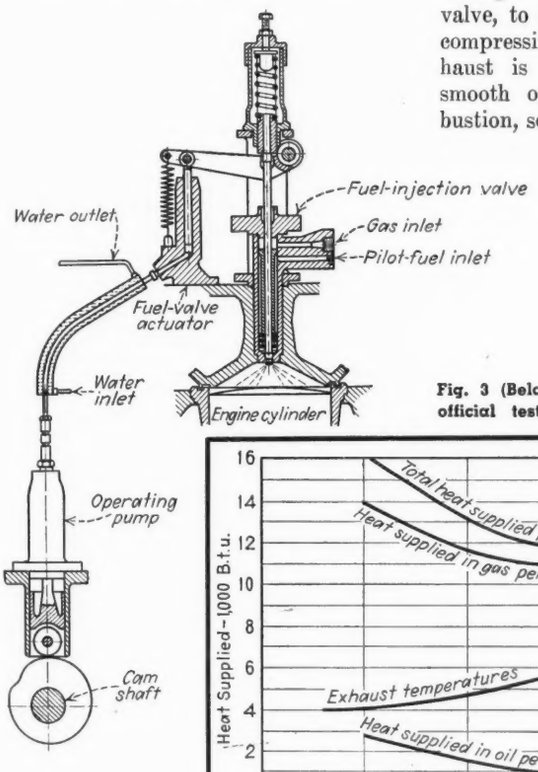
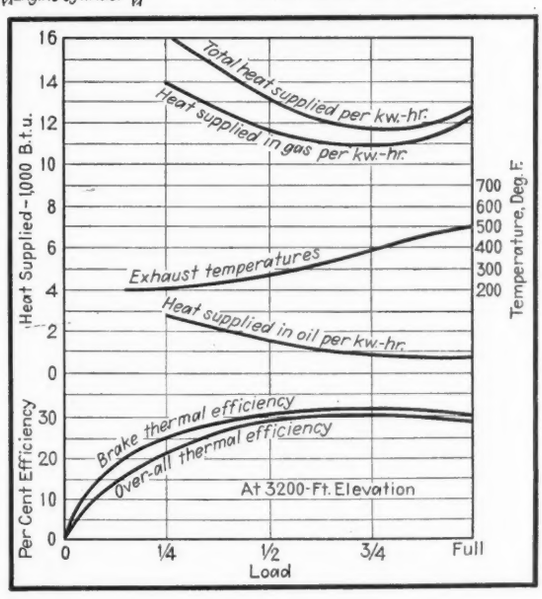


Fig. 2 (Above)—Schematic arrangement for gas operation, showing fuel and operating pump water-jacketed oil line, and fuel-injection valve used for both gas and oil

Pilot oil is delivered to the injection valve by an additional small multiple Bosch pump driven from the camshaft and adjacent to the regular pumps. About 5% of the total B.t.u. of fuel consumed is supplied by the oil, a constant quantity being supplied for any load. These are test results:

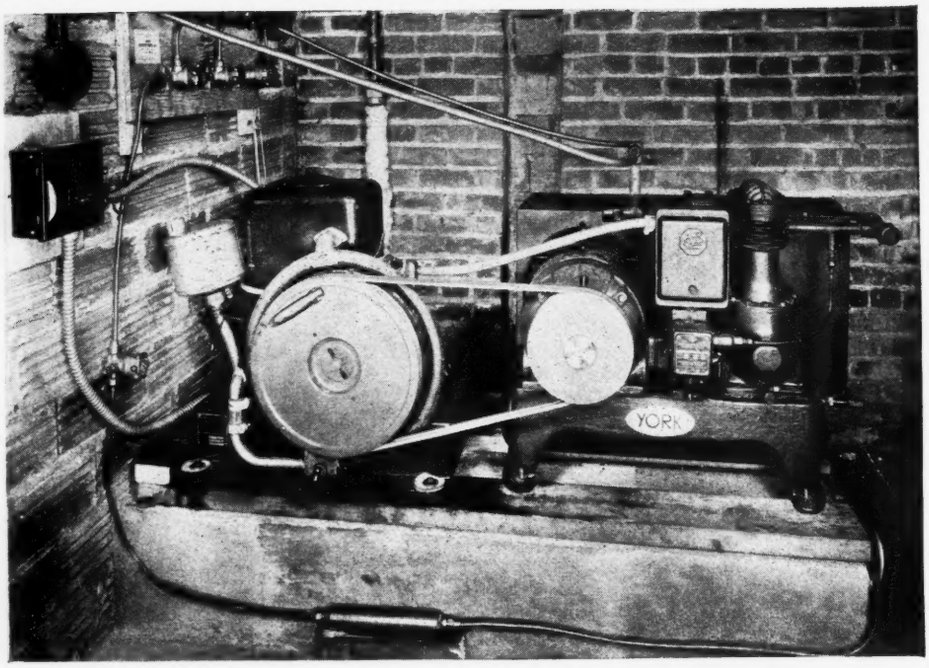
Load	*Full*	¾	½
B.t.u. supplied in oil per kw.-hr.	650	900	1,400
B.t.u. supplied in gas per kw.-hr.	12,000	10,900	11,600
Total B.t.u. per kw.-hr.	12,650	11,800	13,000
Exhaust temperature	500 F	380 F	270 F
Brake thermal efficiency	30%	33%	30%

Fig. 3 (Below)—Results of official tests at Lubbock



From Sept., 1936 to May, 1937, the engine was in service 6,462 of a possible 6,552 hr., or 98.6% of the time at a load factor of about 75%. It is used in base-load service, oil-burning diesels supplying peaks. During these nine months, the engine produced 4,886,400 kw.-hr., burning a total of 53,935,000 cu. ft. of gas with 34.86 lb. of pilot oil per hr. at all loads. Gas cost $7,184.24, pilot oil $1,217.03, a total of $8,401,27. With natural gas containing 975 B.t.u. per cu. ft. and pilot oil 19,200 B.t.u. per lb., and an average load of 757 kw., the engine developed a kilowatt-hour on a total of 11,600 B.t.u. The average kw.-hr. takes 11.05 cu. ft. of gas, costing 13 to 14 cents per 1,000 cu. ft. Pilot oil costs 4 cents per gal. Gas fuel cost is $0.00172 per kw.-hr., as compared with $0.0032 per kw.-hr. for the other diesels, burning 3.1¢ oil, a reduction of 46.2%. Lube oil consumption is low, averaging 5483 hp. hr. per gal.

A second gas-diesel of 2,000 hp. has been purchased from Nordberg.



The first engine-motor combination, a single-cylinder International engine driving a 2-hp. York Freon Compressor in a grocery

Self-Controlled Gas Power

A new arrangement, with the gas engine tied to a motor-driven load, gives completely automatic operation with no control required

By Ralph S. Wenner*

Ohio Fuel Gas Co., Columbus

IN APPLYING natural-gas engines to power loads in and around Toledo, we have had two methods: complete electric-generating plants, or direct connection to a single load. In the first case, investment was high, particularly if standby was provided and ample provision for peak loads. Gas engines are accurately rated and will not carry appreciable overload for even a short period without danger of stalling. Thus it is essential to choose an engine big enough to carry the maximum load, which means that it will usually be carrying less than rated load for 90 per cent or more of the time.

But now we have a new arrangement: Don't replace an existing motor; simply hook the gas engine to it and let everything run in unison. Here is the theory: A gas engine and a mechanical load are both connected to an induction motor, or what may better be termed an induction machine, since only at certain speeds is its behavior that of a motor. Any such induction machine has a synchronous speed; as a motor it operates slightly below that speed. The more heavily loaded as a motor, the slower its operating speed, although lag seldom exceeds 10% of synchronous speed for small motors or 10% for large.

If by application of power to the motor shaft, the motor is caused to rotate at its synchronous speed, it, for all practical purposes, is no longer receiving power from the supply lines. In the case described the gas engine will be driving the mechanical load through the motor as a jack shaft. If engine speed is increased still further, the motor becomes an induction or a synchronous generator, providing line voltage is available for excitation. The voltage and frequency which it generates are exactly those of the supply line, so that it is suitable for use by any other equipment connected to the line. Even if some of it should find its way back through the meter into the neighboring distribution system it could do no harm. It is completely identical with the supply, is dependent upon it for functioning, and fails when it fails.

Flexibility

Through use of this plan, you can take each separate case that you may have for consideration, decide how much of the load you must take, to make for maximum return on the investment, and make the application accordingly. It allows perfectly for flexibility, both for application and operation. Diesel manufacturers advertise that their installations may be amortized in three years. This plan will usually provide for amortization in from 12 to 18 months at gas rates satisfactory to the supplier.

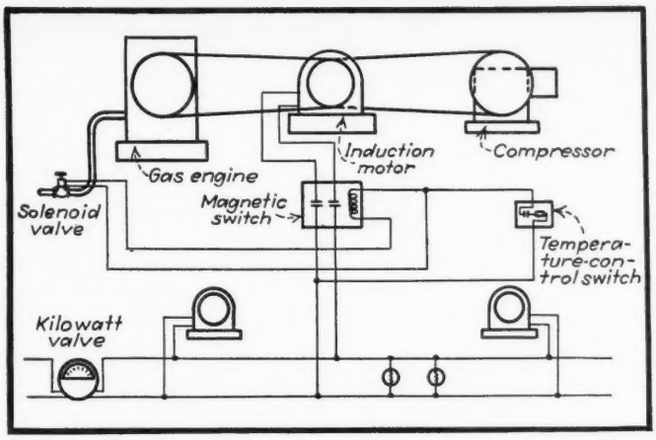
The customer makes a greater saving per dollar of investment than can be made through any other plan for several reasons. First, he can install and use an engine approximately twice as large as would be possible if only the mechanical load were considered. He installs an engine capable of delivering this mechanical load plus an electric load equal to the capacity of the motor as a generator. His initial cost per horsepower is reduced.

Initial investment per horsepower is further reduced because the user need not apply a safety factor for possible overloads. The electrical system cushions this. Also in most cases he needs a simple gas engine without starting equipment, clutch or other auxiliaries.

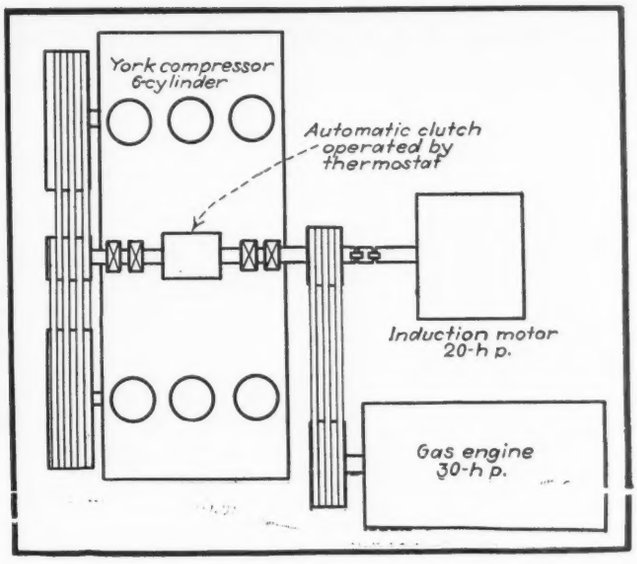
He makes an operating saving because in the normal application, he is operating always at constant full load. Let the mechanical load drop off and the system reaches out and takes a compensating electrical load. Let the mechanical load pick up and the system drops an exactly equal electrical load, literally at lightning speed and with no control devices. The control is inherent in the system itself. It involves only very slight change in speed. Further than this there is no problem of acceleration to impose its penalty of higher fuel costs. This fact of constant full-load operation, for most installations, will bring the best economies the makers can build into their engines.

A further advantage is that the system does not disturb, remove, or replace

*An abstract of a paper before the National Conference on Industrial Gas Sales in Chicago, June 8–9, sponsored by the Industrial Gas Section of the American Gas Assn. and the Midwest Industrial Gas Sales Council.



A simple single-phase installation involving an automatic refrigeration load and auxiliary power and lights



A proposed installation for air-conditioning load, permitting use of engine and motor throughout the year

any existing equipment; it merely supplements it. The user still has an electric motor connected to his load and hooked up with central station service. If the gas engine fails, the wheels keep turning just the same. If automatic controls are installed, the system does not disturb them. Without touching them, they may be applied to the gas engine through the motor. The fear in the customer's mind of cutting away from utility service is eliminated, yet no lineshafts, at least not mechanical lineshafts, are introduced. Perhaps it is proper to consider that we have introduced a flexible electrical lineshaft into the gas-engine picture. Within certain narrow limits well within the tolerance prescribed for most loads, we have the most perfect speed control imaginable.

While this plan has so far been limited to commercial refrigeration and auxiliary power and lighting, it can be used for summer and commercial air conditioning. Also nearly every industrial plant will provide one or more applications, most of them running into sizeable revenue.

Here is an example: Gerber's Grocery in May, 1936, used 872 kw.hr. for a connected load of 3.5 kw. This cost $31.86, which with the minimum gas then used, cost $32.63. Last May, with a gas engine connected as described, the total electric bill was only $4.58, the gas bill (14,000 c.f. @ $0.59 per M) $8.25, a total of $12.83. The saving was $19.80, to be applied to amortization of the engine. Average consumption was 17.7 cu.ft. per kw.hr. An ice cream plant similarly saved $48.84 on 4118 kw.hr. consumption, using 14.4 cu. ft. per kw.hr.

An industrial plant in April, 1936, paid $810.30 demand charge (438 kw.) and $1362.04 for power (total consumption 142,880 kw.hr.), a total cost of $2,172.34. A 1400-r.p.m., 156-hp. Hercules gas engine was installed to handle 40 hp. of mechanical load and 79 hp. of electrical. Demand dropped to 349 kw. for a charge of $645.65 and current cost to $1067.64 (107,200 kw.hr.), a total of $1713.29 for electricity, plus $238.50 for gas, so that net operating savings were $220.56. This could be increased by using recoverable jacket water and exhaust heat, and would of course be decreased by maintenance, insurance and amortization costs.

Diesels in England

Extracts from two reports before the Diesel Engine Users Assn., 56 Victoria St., S.W.1, London, England, show the trends there in plant design

THE BULLETIN of the Diesel Engine Users Assn. summarizes annual progress. These extracts are from the section on Stationary Power Generation.

Elimination of air-injection equipment and the attendant multi-stage air compressor (which materially reduces the insurance premium) has simplified designs. Solid injection has also caused almost universal adoption of the small, high-speed, enclosed, high-compression engine for all sorts of portable services, as well as for small light and pumping plants. Such engines work in the open, practically unattended. In England and the Colonies, diesels have practically superseded gasoline and kerosene engines for these services, and have proved economical and exceedingly reliable.

The best order of merit on which to select an engine is reliability, lubricating and fuel-oil consumption. Reliability is certainly much more important than low test-bed fuel-oil consumption. Greater understanding of the combustion problem has resulted in improved internal conditions and much reduced lubricant consumption. While the slow- and moderate-speed 2-cycle engine is pre-eminent for powers over 3,000 to 4,000 b.hp., there has been no outstanding change.

Aluminum and non-ferrous light-alloy pistons permit engine speed to be stepped up materially, but cause a higher rate of cylinder and piston-ring groove wear, thus increasing maintenance costs. It is suggested that correctly designed cast-iron pistons will avoid this wear. The higher inertia forces relieve main-bearing pressures, and connecting-rod bolt stresses can be kept within safe limits by increasing the number. When extreme lightness is vital, high-tensile, low-expansion alloy steel is worth considering. It does not distort under high temperatures, does not crack under rapidly changing stresses, and gives excellent wear.

Work still must be done on the proper size of crankcase sump, particularly for high-speed engines. Under maintained high load, temperatures of the limited amount of oil available rises rapidly, reducing oil viscosity and adversely affecting lubricating film. This means rapid bearing wear and eventual cracking and breaking of the babbitt.

Many horizontal engines are being sold to the base-metal and gold-mining industries, and some factories are also installing such engines, averaging around 250 to 300 hp. at 375 r.p.m. A standby installation for the swing bridge at Kincardine-on-Forth uses a 4-cyl., opposed-piston, 330-r.p.m., 120-hp. 4-cycle, horizontal engine with enclosed valve gear. It is started and stopped by remote control.

Another plant, composed of three 6-cyl., 327-r.p.m. 550-hp. generating sets, is installed for Bahrein Petroleum Co.

on Bahrein Island to work in conjunction with a 2,000-kw. extraction-type steam turbine. Conditions are bad: shade temperature 114 F, humidity 70%, prevailing sand storms, bad water, and raw petroleum for fuel. Yet, each of these engines works 1,000 hrs. non-stop.

Two installations of the convertible type are mentioned in the report. Birmingham Tame and Rea District Drainage Board has a 6-cyl., 300-r.p.m. 4-stroke engine supplying 540 hp. when operated on sewage gas and 630 hp. as a diesel. Mogden Works of West Middlesex Main Drainage has 17 engines, ten of which are convertible to supply 550 b.hp. as gas engines (methane) and 650 b.hp. as diesels. Four drive d.c. generators, the other six 3-stage centrifugal blowers through hydraulic couplings and double helical gears.

Operating Reports

J. Calderwood reported in a recent survey that, using English diesels as a basis, there has been a steady improvement in average fuel consumption. Lubrication-oil reports, however, show a more erratic tendency, and "average consumption is, if anything, worse today than in 1925." This has been caused by aiming at higher specific output or lower fuel consumption, which undoubtedly sacrificed low consumption of lube oil.

On repair costs, Mr. Calderwood says, "There was steady improvement until 1928, but since then the average figure from all home (in the British Isles) stations has remained remarkably constant. The life of the engine and its reliability are not tangible things which can be measured by figures, but repair costs no doubt give some measure of these properties. Engineers condemning the increased speed of modern engines speak of the wonderfully slow-running old engines which never gave trouble and many of which are still in service. The comparison of repair costs seems to indicate that the average modern engine is at least no worse, and probably better, than its older brother. Of course, there have been exceptions to this, as to any other generalization, usually due to attempts to advance too rapidly."

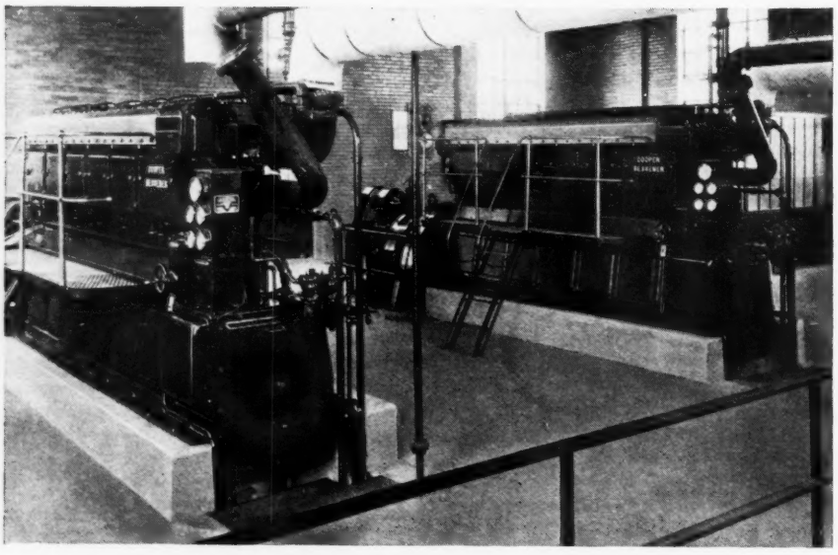
Improvement in fuel-injection systems has had a major part in bettering fuel-oil consumption. Design of the fuel valve has been condensed—sprayer, needle seat, and needle guide have been made in one piece, thus avoiding unnecessary high-pressure joints and insuring eccentricity of needle and seat so that probability of valve leakage disturbing atomization is reduced to a minimum. Main advance in fuel-pump design has been the shaping of the cam to produce the conditions of pressure rise, rate of pumping, etc., necessary to correct functioning of the fuel valve.

Much of the mystery that formerly surrounded the combustion space has been dispersed, and the wide variety of pre-combustion chambers, swirl chambers, etc., have almost totally disappeared, except in certain high-speed engines. The trend is today towards an open combustion space which prevents oil from touching the metal walls of the combustion chamber. Mr. Calderwood remarks that there is a wide variation in the actual shape of the chamber according to the jet arrangement in the fuel sprayer, but that the general attempt of the designer is to give a small superficial area compared to the volume of the space and to avoid scouring cold surfaces by excessive turbulence in the gas either before or after combustion.

Combustion pressure has been increased, which is said to account for at least 2 to 3% of the improvement in fuel consumption. Although solid injection reduced upkeep costs by eliminating a compressor and symplifying the injection equipment, increased combustion pressure would have shortened piston-ring and cylinder-liner life had not better materials been developed.

A large part of specific output improvement is due to increased piston speeds made possible by improved bearing design and quality of bearing metal. "On any individual engine, increased speed results in higher fuel consumption. However, with the increase in piston speed that has taken place in recent years, this tendency to increased fuel consumption has been more than counterbalanced by improvement in mechanical efficiency due to better detailed design and by better scavenging of the cylinder due to improved valve design on the 4-stroke and improved port design on the 2-stroke engine."

Connersville, Ind., is reported to be saving $31.80 a day with two new diesels in its waterworks. Three new pumps have been installed, but one provides more water than formerly. The two 363-hp., 400-r.p.m., Cooper-Bessemer diesels are direct-connected to 250-kw. generators. Cost including labor, overhead and estimated depreciation is $14.20



Pressure Changing

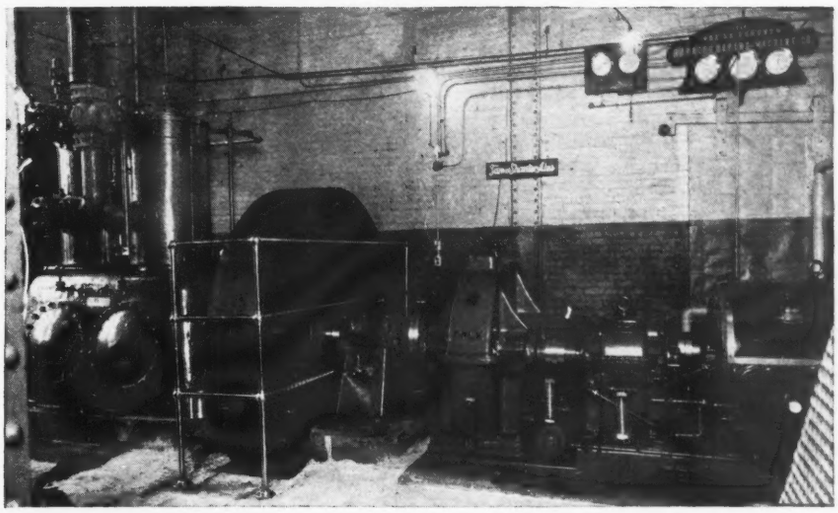
Pressure charging is described as one of the methods of improving engine output which has been gaining in popularity in recent years. A number of systems have been devised which fall under three general classifications: (1) Exhaust-turbine pressure charging. (2) Pressure charging with separately-driven or engine-driven blowers which compresses all air to the required pressure before it enters the cylinder. (3) "Topping-up" system, in which only a portion of the air is compressed to the higher pressure and is admitted to the cylinder after it has been filled with air at normal pressure.

The first of these systems is the most widely used in England, and is commonly fitted to 4-cycle engines. This increases engine cost slightly, of course, but the system is said to give an increased output of 45% under normal commercial operating conditions. It is necessary to adjust timing of inlet and exhaust valves, and in some cases, to alter the exhaust-pipe arrangement, but exhaust-turbine pressure charging is said to give an increased output at a cost between $\frac{1}{2}$ and $\frac{3}{4}$ of the cost of an additional plant (adding in cost of blowers, etc.) without any increase in specific fuel consumption.

Pressure-charging all air going to inlet valves is claimed the cheapest method of increasing engine output, but suffers from the disadvantage that there is an increase in fuel consumption. Provided, however, that output increase is limited to about 20%, increase in fuel consumption will not be more than 3 to 5%.

In the "topping-up" system, the most common application is one in which inlet and exhaust systems are arranged as in a normal 4-cycle engine, but there is in addition a row of scavenging air ports at the bottom of the cylinder liner. These ports are uncovered at the beginning of the exhaust stroke and a small charge of air enters the cylinder; the exhaust gas is pushed in front of this, thus leaving the cylinder completely free of gas. Ports are again uncovered at the end of the suction stroke, valve timing being arranged so that the suction valve is closed before ports are uncovered. Ports then charge the cylinder with air up to the delivery pressure of the air pump.

This system gives an increased output (about 25%) with somewhat cooler running, a feature of all pressure-charged systems when properly applied.



Right to left: 2,000-sq. ft. turbine (4,500 r.p.m. top speed); herringbone reduction, 4,500 to 983 r.p.m.; herringbone reduction, 983 to 185 r.p.m.; 2-cyl., 14x16-in., 125-ton (nominal) ammonia compressor

By Frank L. Wadsworth
Professional Engineer

Condensing Turbine Drives Ammonia Compressor

Breaking sharply with tradition, American Brewing Co., Inc., Rochester, N. Y., hooks a variable-speed turbine to piston compressor through double reduction gears

SOME ENGINEERS said, "It has never been done before." But American Brewing Co., Inc., Rochester, N. Y., accepted the challenge and made a successful installation of a steam-turbine-driven ammonia compressor.

When the brewing company decided to add another compressor at the beginning of 1937, the power plant contained one 3,000-sq.ft. B & W and one 4,000-sq.ft. Foster Wheeler, 250-lb., 3-drum, low-head, water-tube boiler; Westinghouse single-retort, side-dump, underfeed stokers; B. F. Sturtevant forced-draft fans; and two boiler-feed pumps, one Gould triplex motor-driven and the other a Worthington duplex steam-driven.

In the engine room were two Ames uniflow steam engines direct-connected to Crocker-Wheeler, 125-kva., 3-phase, 60-cycle, 220-volt, a.c. generators, with belt-driven exciters; one 65-ton Ingersoll-Rand engine-driven ammonia compressor and one steam-driven air compressor (non-condensing, 170 lb. with 5 lb. back pressure); two motor-driven Ingersoll-Rand air compressors; one 50-ton York ice machine with synchronous motor drive. There were also several motors scattered around the brewery to drive pumps, mash tubs, etc.

The owners considered these facts: Additional motor-driven equipment would involve either more generating capacity or purchase of current, neither of which they desired to do at that time. And more non-condensing steam-driven equipment would mean waste of exhaust steam, particularly during summer months when load is heaviest.

The consulting engineer, Siegmund Firestone of Rochester, N. Y., after study of the plant, recommended a steam-turbine-driven compressor, to operate condensing. And in spite of a chorus of "nays," he got in touch with various turbine and reduction-gear manufacturers, and found one who would guarantee the gear, provided that the compressor manufacturer would furnish data on the flywheel effect and flywheel weight of the compressor.

Alterations

Boiler safety valves were equipped with new springs and reset from 175 to 250 lb. Some alterations were made to existing piping, including a reducing valve to maintain 170-lb. pressure on the steam main supplying the engines. A new 250-lb. line was run to the turbine, which operates with 235-lb. steam and 27-in. vacuum at the throttle (steam consumption under rated conditions not to exceed 15.4 lb. per b. hp.hr.). A feedwater regulator was added for each boiler and several more spray nozzles at the spray pond to meet increased demand for condensing water.

Though the compressor and turbine have been in service only a short time, they have come up to expectations and proven very quiet in operation. I believe that this installation will lead to many developments along similar lines and will open an almost untouched field. With higher pressures and superheated steam, it has been necessary to reduce and desuperheat high-pressure steam for reciprocating engines, engine-driven air or ammonia compressors, etc. This installation, however, eliminates many complications, and it is reasonably safe to say that within a short time, turbine-driven compressors with 400- and 600-lb. superheated steam will be common.

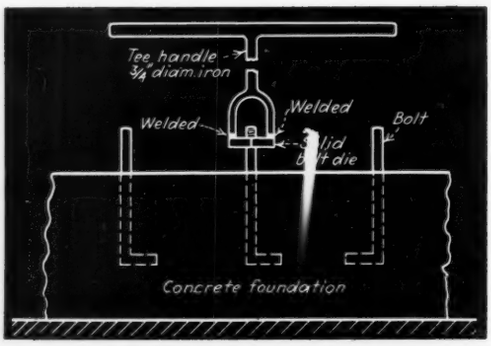
Principal equipment installed was: ammonia compressor—14x16-in., 125-ton, York Ice Machinery Corp.; General Electric steam turbine—4-stage, impulse, with one 2-row, Curtis high-pressure and 3 Rateau low-pressure wheels (stainless-steel blading throughout). Auxiliary turbine equipment includes a direct-acting, oil-operated, variable-speed governor for regulating compressor speed from 84 to 185 r.p.m.; emergency overspeed and vacuum breaker; ring oiler bearings and force-feed lubrication.

Two reduction gears, one a Terry herringbone with forced lubrication reduces speed from 4,500 to 983 r.p.m.; the other, a Falk herringbone connected to the compressor with a Falk No. 20, 9-in. bore flexible coupling, reduces speed from 983 to 185 r.p.m. The surface condenser, Foster Wheeler, 3-pass, 8 ft., 6 in. long, containing 300 sq.ft. of ¾-in. copper tubes, condenses 4,000 lb. of steam per hr., using 310 g.p.m. cooling water at 80 F entering temp. and 27-in. vacuum. The 2-stage, steam-jet air pump, centrifugal condensate and circulating pumps are also Foster Wheeler.

Other equipment: expansion joints, Foster Wheeler (Wainwright); receiver separator and multiport back-pressure valve, Cochrane Corp.; reducing valves, Ruggles-Klingemann Co.; motors, General Electric Co.; high-pressure traps, Kaye & MacDonald Co.; valves, Jenkins Bros. Co.; fittings, Grinnell Co., Inc., and Crane Co.; steel pipe, National Tube Co.; wrought-iron pipe, A. M. Byers Co.

The writer acted as engineer in charge. Installation of piping and machinery was supervised by Edward S. Dyer, chief engineer of American Brewing Co., Inc.

PRACTICAL AIDS TO OPERATION



Rethreading Anchor Bolts in Close Quarters

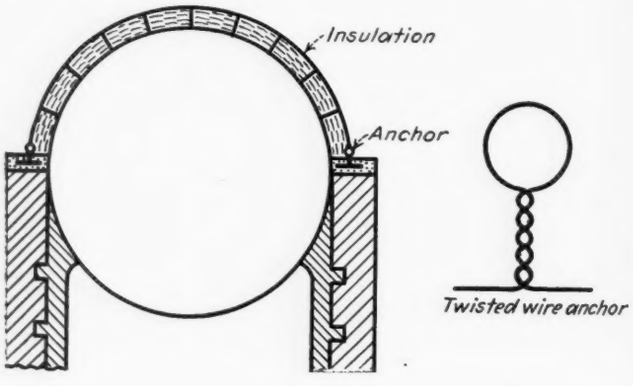
ON A rebuilding job we had to shorten and rethread several anchor bolts extending from an old concrete foundation. Hooked ends of the bolts were permanently embedded in the concrete with threaded ends extending 5 in. above the concrete. We had to cut about 3.5 in. off the bolts and rethread them for new equipment to go on the foundation.

Bolts were spaced so closely that an ordinary die stock could not be used. To do the job, a T-shaped handle about 14 in. long was made of three 0.75-in. iron rods for the bolt die. This handle terminated in a yoke, the spread of which equalled the distance between two diagonal corners of an ordinary square bolt die. A bolt die of proper size was welded, at two diagonal corners, to the handle, as shown in the figure. This tool worked so successfully and has proved so convenient in rethreading anchor bolts that it has since been used on many jobs in place of a conventional die stock.

Sioux City, Iowa P. A. STARCK

Fastening Insulation on H.R.T. Boilers

WHEN heat-insulating material is applied to the exposed portion of h.r.t.-boiler shells, wires or wire netting used to hold the covering in place should be fastened securely. Satisfactory anchors for this purpose can be made by twisting short lengths of heavy wire, shown in the accompanying sketch, and placing them in the top of the setting walls during construction. Eyes should be placed the thickness of the insulation away from the boiler shell and be spaced 6 or 8 in. apart along the length of the boiler on each of its sides.

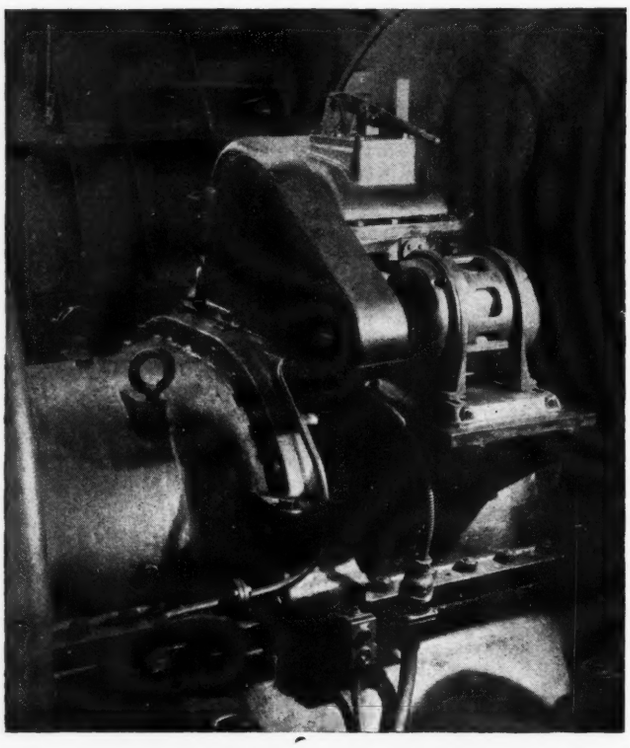


Richmond, Va. C. R. ANDERSON

Turning Gear Cuts Starting Time of 80,000-kw. Unit

BROOKLYN Edison Co. has installed a slow-speed turning gear on the 80,000-kw. turbo-generator in its Hudson Avenue Station to keep the turbine rotating when it is out of service. By continuing rotation at 3.1 r.p.m., spindle eccentricity is reduced to a minimum during cooling, and starting is accomplished in a much shorter time than possible if the spindle remained at rest. This saving in time varies, but usually length of time required to start the turbine is reduced from 50% to 75% of its normal starting time required under previous practice.

Turning gears were first developed about 10 years ago, and since then most large turbines have been factory equipped with these devices. This 80,000-kw. unit is one of the largest machines to which a turning gear has been applied. The turning gear harmonizes with the general design of the turbine (see photo) and does not mar its general appearance. When the turbine comes to rest, the operator pulls a lever to throw a turning-gear pinion in mesh with a spur gear on the turbine spindle. The 10-hp. turning motor is then started and through a chain and reduction gears keeps

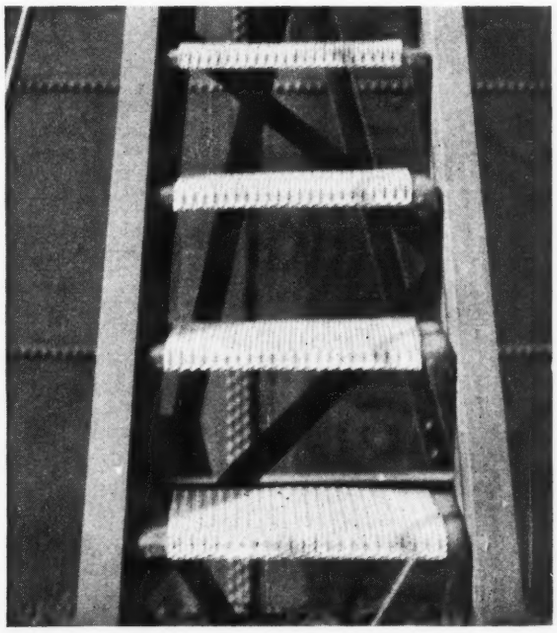


the turbine spindle shaft revolving at very slow speed.

The turning gear was installed on the turbine during a periodic shutdown overhaul. Only the coupling had to be returned to the factory for mounting the spindle gear. All the other equipment was installed in the field. New covers were provided for the bearing between the turbine and the generator, upon which was mounted the turning gear. The gear was installed in less than a week and was able to go immediately into service without being dismounted for adjustment.

The machine is a cross-compound unit, as are the two 110,000-kw. machines at Hudson Avenue. The two large machines were equipped with turning gears on both high- and low-pressure spindles at the factory. Operating experience with the 80,000-kw. turbine has shown such small deflections in the low-pressure spindle that it was felt the low-pressure part of the machine could not limit its starting time. Accordingly, on this field job it was decided to put a turning gear on the high-pressure spindle only, where shaft deflections are greater because of wider variations in temperature.

New York, N. Y. T. FORT and F. M. GARRETSON
Westinghouse Elec. & Mfg. Co.



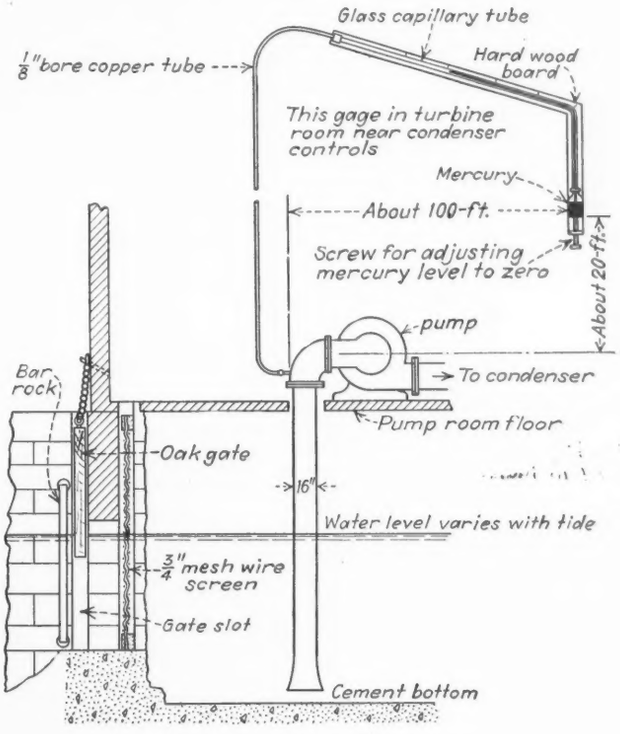
Non-Skid Surfacing for Worn Treads

EXPOSED metal stairs with the usual form of pressed-steel steps gradually wear smooth. This condition, besides being a hazard, introduces a fire risk if, as in the oil industry, the steps lead to tanks containing volatile or inflammable petroleum products. Though fortunately rare there are tank fires on record where the only possible cause of the igniting spark was action of sand or gravel on steel under the heel of a man mounting the steps at the time.

One large oil company found that stair treads wore smooth long before the steps themselves needed replacing. The problem of roughening treads inexpensively was solved by taking ordinary expanded metal lath, doubling it for thickness and resiliency, and wiring it around the steel treads of worn flights, as shown in the photo. By using galvanized lath, not only was the problem of rust solved, but also the more serious one of possible sparks, as the heavy zinc coating will not spark, no matter how sand laden it is.

Cleaning of retreaded steps is easily done with an ordinary hand bellows, or with a hose if flushing facilities are available.

Longview, Texas ELTON STERRETT



Mercury Gage Measures Pump Suction

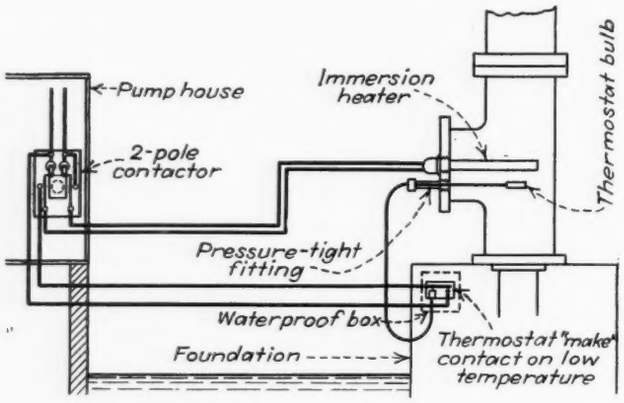
A MERCURY gage registers depth of water in a suction basin from which salt water flows to two barometric condensers through a centrifugal pump. Masonry walls enclose the basin, which is under the pump-housing floor, about 100 ft. from the turbine room and 15 ft. lower. Water is admitted to the basin through a bar rack on the seaward side and a ¾-in. wire-mesh screen inside the pump-room wall. Normal tide variation is about 9 ft. with an occasional extreme of 15 ft.

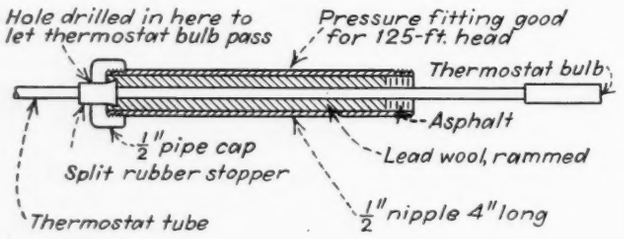
On a severe winter day the 2,000-kw. turbine suddenly lost its vacuum from lack of condenser water. Inspection of the suction basin disclosed that it was dry, small ice particles having clogged the screen. To prevent this trouble recurring without warning, the suction ell at the pump was tapped for a ⅛-in. nipple and valve. A ⅛-in. copper tube was run from this connection to a glass tube with its lower end immersed in a bottle of mercury, mounted on a hard wood board on the engine room wall.

The pump is driven by a steam turbine controlled by a pressure regulator to give constant pump-discharge pressure. Speed of the pump varies with the tide. Therefore, vacuum in the suction line increases or de-

creases to correspond with the tide level and the mercury rises and falls in the glass tube accordingly. Comparison of the mercury column with the tide level outside the pump room indicates whether the level of water in the basin is being maintained. Although extreme accuracy is not essential, the gage was found to be accurate within 0.2 of a foot.

Plymouth, Mass. C. B. HUDSON





Electric Heaters Protect Standpipe

TO PREVENT a 36-in. exposed and uninsulated cast-iron standpipe from freezing, two 5-kw. immersion heaters were screwed into the blank flange on a tee at the standpipe from freezing, two 5-kw. immersion heaters lower, the flange was tapped for 0.5-in. nipple into which a thermostat was inserted. Connections are self-explanatory. Mild winters made it improbable that the standpipe would freeze very often. In addition the thermostat was set at 35 F to make freezing impossible.

Bedford, Pa. GEORGE R. ELDER, JR.

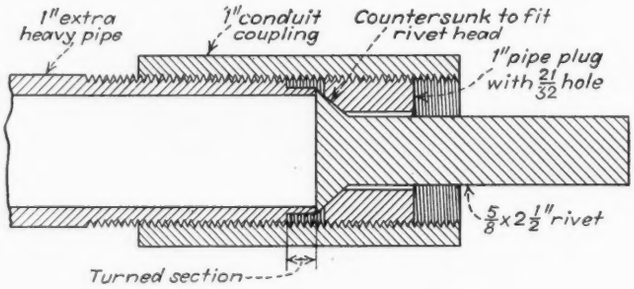
Combustion-Rate Control Maintains Boiler Pressure

CONSTANT STEAM pressure on a boiler requires that heat be supplied to the boiler at the same rate it is taken out. Any unbalance causes a change in steam pressure. This quite obvious fact is often overlooked when constant pressure is required under varying loads. It used to be assumed, and sometimes still is, that large drums on boilers assist in maintaining constant pressure when steam demand does not synchronize with combustion rate.

Large drum capacity may have a dampening effect upon pressure fluctuations, but it is easy to overestimate this. At 100 lb. gage pressure, 1 lb. of steam has a volume of over 4 cu.ft., so that the equivalent of only 30 lb. of steam has a volume of more than 120 cu.ft. It is therefore obvious that the amount of reserve steam in even a very large drum boiler is more or less neglible. Only a very small part of this can be drawn upon without a large drop in pressure. A great many more heat units can be stored in a cu.ft. of water than in a cu.ft. of steam, but even this cannot be drawn upon, without a drop in pressure.

With a high-set, water-tube boiler, heat-storage capacity of the brick setting is considerable and may prove to be of greater importance in maintaining constant pressure than heat capacity of the boiler itself. On one occasion, when a test was being run on a 3-burner, high-set Stirling boiler, a two hour check on a light night load, with only one burner in operation, showed an efficiency of over 100%. This, of course, was due to heat being reclaimed from the boiler setting. It is sometimes difficult to prevent pressure building up from this cause when boiler load is very small. The natural conclusion is that the one correct way to control steam pressure is by control of combustion rate.

Bloomfield, N. J. JAMES O. G. GIBBONS


1" extra heavy pipe
1" conduit coupling
Countersunk to fit rivet head
1" pipe plug with 21/32 hole
5/8 x 2 1/2" rivet
Turned section

Chuck for Threading Countersunk Bolts

AT OUR PLANT we use a large number of 5/8x2½-in. countersunk bolts on the retort side plates of our stokers. We found that we could save about two-thirds their cost by making them from countersunk rivets. If slots are needed in the rivet head, they are put in with a hacksaw before threading in a special rivet-holding tool, shown in the figure.

This tool is made from a piece of extra-heavy pipe threaded on one end, with about one-quarter of the thread cut away. A coupling, into which is screwed a standard pipe plug with 21/32-in. hole in its center, is threaded onto the pipe. The hole in the bushing is countersunk to fit the rivet heads and the coupling is formed to act as a guide in an adjustable bolt die.

When rivets are threaded the pipe section is clamped into a lathe head, the rivet is dropped through the hole in the plug and the coupling screwed into place and tightened with a pipe wrench. The lathe is turned and the die applied to the rivet. When the proper length of thread is cut, the lathe is reversed and the die screwed off. With this equipment it is possible to thread 40 rivets per hour.

Wilmington, N. C. GEORGE C. AVANT

THE ENGINEER'S BOOKSHELF

Fluid Mechanics

APPLIED FLUID MECHANICS (1937)—*By M. P. O'Brien, Professor of Mechanical Engineering, University of California, and G. H. Hickox, Hydraulic Engineer, Tennessee Valley Authority. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Cloth cover, 360 pages, 6 x 9 in., 160 illustrations, 22 tables. Price $3.50.*

For many years the motion of fluids has been treated under various specialized headings, such as hydraulics, aeronautics, and acoustics. As a result, many teachers, students and engineers have failed to realize the relatively small number of underlying principles necessary to deal with motion of air, water, steam, oil or any other true fluid. The rapid development of aeronautics and the application of aerodynamic principles to hydraulics and other branches of fluid mechanics have emphasized the need for a study of principles common to all these subjects, a need that the authors have filled in this text.

Subject matter is divided into ten chapters and two appendices: equilibrium in fluids, hydrostatics; flow phenomena; frictionless flow; viscosity, turbulence and friction; weirs, orifices and gates; forces exerted by fluids; steady flow in hydraulic pipelines; unsteady flow in pipelines; flow in open channels; models of open-channel flow; physical properties of fluids; and hydraulic tables.

Modern Diesels

THE MODERN DIESEL (4TH EDITION)—*Published by Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1, England. 223 pages, 5 x 7 in. Price 3/9 (slightly less than $1).*

Thoroughly revised and enlarged to cover continued development of transport diesels, this is a handbook on high-speed units for all motive-power applications. It deals principally with British and Continental designs and includes alphabetically arranged tables of characteristics and principal dimensions. One new chapter deals with locomotives and railcar engines; another discusses the many new types of injection pumps.

Motor Application

MOTOR AND CONTROL APPLICATIONS (1937)—*By George H. Hall. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. Cloth cover. 259 pages, 6 x 9 in., 167 illustrations, 17 tables. Price $3.00.*

Planned to link motors and controls produced by their manufacturers and the tool or machine designed by the machine builder, this practical book goes a long way toward accomplishing its object. The first half of the book is devoted to modern motors and control equipment and the latter part to motor and control applications. No attempt is made to deal with details of motor design and operation; emphasis is placed on characteristics obtainable from various types of motors and the performance that may be secured from them by selecting suitable control.

Besides descriptions of the various types of motors there are covered protective control devices, control accessories, stopping devices, motors for quiet operation, motor and control enclosures for hazardous conditions, high-frequency induction motors, shaftless motors, integral speed reducers, and application of motors to all conceivable types of equipment.

I. C. Engine Testing

THE TESTING OF INTERNAL COMBUSTION ENGINES (1937)—*By S. J. Young and R. W. J. Pryer, Loughborough College, London. Published by D. Van Nostrand Co., Inc., 250 4th Ave., New York, N. Y. 200 pages, 5½ x 8½ in. Price $3.25.*

As H. R. Ricardo says in his foreword to the book, "The testing of internal combustion engines is by no means the simple problem it appears." Engines cannot simply be placed on the test block and their fuel consumption and delivered horsepower determined. The tester must go on and work with the engine until he has it running at its best—which often requires much maneuvering. It is a test of the tester as well as of the machine.

The book deals with testing from the engineering-college point of view, being a manual for that type of laboratory test on medium-size engines. There are some data relating distinctly to the diesel, and of course, much of the general data is generally applicable.

Strength of Materials

STRENGTH OF MATERIALS (3RD EDITION)—*By Alfred P. Poorman, Prof. of Applied Mechanics, Purdue University. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 314 pages, 6 x 9 in. Price $3.*

Two articles on welded joints, an article on shearing stresses in noncircular shafts, data on shear centers of channel sections, "H" sections with unequal flanges and angle sections have been added. Torsion of shafts has been moved forward in the text, all material on elastic resilience has been placed together, and continuous beams with fixed ends and unequal loads or spans have been treated. Moments and stresses in beams due to moving loads are discussed. There are also additional examples, and the equivalent cantilever method of figuring deflection of beams has been omitted.

Two-Cycle Diesels

ZWEITTAKT DIESELMASCHINEN KLEINERER AND MITTLERER LEISTUNG (TWO-CYCLE DIESELS OF SMALL OR INTERMEDIATE RATING)—*By J. Zeman. Published by Julius Springer, Vienna. 245 pages, 240 illustrations. Price, 20 Reichsmarks.*

In early attempts to build small 2-cycle diesel motors to compete with the 4-cycle type, quality was sometimes sacrificed for cheapness. It is being gradually recognized, the author states, that for certain conditions the 2-cycle may not only equal but may surpass the 4-cycle, and renewed efforts have been made to increase the output per unit volume of cylinder.

The first part of the book is devoted to design computations, stressing those features which are peculiar to the type in question and passing over those which are common to both types. Considerable attention is devoted to the scavenging process; other sections take up limitations of size, choice of compression, injection and design of combustion chamber. The mathematical treatment is generally simple, with liberal use of diagrams and charts. The second, and somewhat larger, section deals with details of construction, cites the practice of various manufacturers and includes practical data.

BRIEF REVIEWS

STEEL HORIZONTAL-FIREBOX HEATING BOILERS (1937)—*By National Bureau of Standards, U. S. Department of Commerce. For sale by Supt. of Documents, Washington, D. C., 5 cents*—16-page pamphlet describing simplified practice recommendation No. R157-37.

DEGREE-DAY HANDBOOK (2ND EDITION). *By Clifford Strock, associate editor, and C. H. B. Hotchkiss, editor,* Heating & Ventilating. *Published by The Industrial Press, 148 Lafayette St., New York, N. Y. Price, $3.*—A degree-day handbook for checking heating-plant operation and predicting fuel consumption. 298 pages, 6 x 9 in., 29 tables, 27 illustrations, including a degree-day map of the U. S.

DESIGN OF WELDED PIPING (1937). *Published by Linde Air Products Co., 205 East 42nd St., New York, N. Y. Distribution on request*—200-page handbook on design and layout of piping for welded connections. Over 100 figures and tables.

SIMPLE AND DIRECT ANSWER TO ALL PROBLEMS OF HEAT TRANSFER IN BOILERS (1937). *Published and written by Loyd R. Stowe, 749 Linden Ave., Wilmette, Ill.*—90-page book designed to give practical answers to frequently-arising questions on heat transfer in boilers. Basis for book is a series of 500 tests made on a pair of twin boilers. Answers are given to such questions as: What should govern tute spacing? What controls length of a boiler tube? What influence has the tube diameter on heat absorption?

CURRENT COMMENT

Preparing Heating Insulation Before Painting

WHILE the answers in May *Power* to the question concerning preparation of insulated surfaces before painting were comprehensive, no mention was made of a recent development in finish coats for bare asbestos and magnesia surfaces. These preparations, obtainable from leading insulation manufactures, form a tough, flexible, waterproof finish and are easily applied with a trowel. The material is composed of long-fibre asbestos mixed with an asphaltic or bitumastic emulsion. A similar finish having high heat-resistant properties can be made with chrome-asphalt emulsion (DuPont) and long-fibre asbestos.

Flexible coatings of this type have many applications. They are ideal for finishing large areas, as for example, insulating tanks, feedwater heaters, air ducts, boiler drums and heads and similar equipment. The finished surface can be easily and neatly patched when necessary, as no canvas is required. It can be painted any desired color, but must first be sealed with aluminum paint or other sealer to prevent the binder from burning through finish coats of paint.

New York, N. Y. M. O. WHEELING

Thermostatic Control of Deaerator Temperature

I HAVE read with interest the discussions of deaerating-heater temperature control in January and May issues of *Power*. It has been my experience that thermostatic control of deaerator makeup steam is not practical for two reasons: first, the inherent lag in the bulb and tubing systems of this type of controller and, second, effect of heater water-storage capacity.

Water is heated in the usual deaerator by direct contact with steam in finely divided droplets or a thin film. Suppose the temperature-responsive element of the thermostatic controller is located in the region where water is heated and there is a sudden drop in the inlet-water temperature. Steam in the heater immediately condenses and because of controller lag a quantity of low-temperature water falls to the water-storage space, thereby reducing temperature of the stored water and by convection temperature at the deaerator water outlet.

Finally, the makeup-steam valve opens and restores steam pressure to the heating chamber. When pressure and temperature become normal the controller starts to close the valve, but, because of lag, steam still enters the heater to build up excessive pressure which may cause the relief valve to open and waste steam.

When the element is placed in the heater-outlet water line, lag still exists and is further complicated by storage capacity of the heater. In other words, the thermostatic element tries to correct temperature of water that had passed through the steam space of the heater some time before.

With pressure-controlled makeup steam these conditions do not exist. Low-pressure reducing valves commonly used in this service are equipped with large diaphragms that are extremely sensitive to even slightest pressure variations. When it is considered that a temperature drop of 1 F in a heater designed to deliver 225-deg. water with 5-lb. gage steam pressure means a pressure drop of approximately 5 oz., it is easily seen that the reducing valve would have started opening to restore conditions to normal long before the pressure had dropped even this small amount. On an increase of pressure the action is just as speedy.

Richmond, Va. C. R. ANDERSON

Additional Errors for What's Wrong—XV

THESE additional items should be added to the list of errors on "What's Wrong With This Picture—XV", page 409, July *Power*, which showed a storage-type hot-water heater.

1. The heater should be insulated.
2. Heads should be dished instead of flat.
3. It is stated that the cold-water line should be at the bottom of the heater. This is satisfactory, except that a splash plate should be provided inside the heater to distribute cold water better.
4. Heater should be properly supported.
5. If high-pressure steam is used, it must be reduced to the safe working pressure of the heater, which means that reducing and safety valves should be installed on the steam line to heater.
6. As the ordinary type of relief valve will bake on its seat when installed on this type of heater, the relief valve should be on the feed line.
7. A pressure gage should be installed on the cold-water line to ascertain incoming pressure, as a large drop in pressure would not supply water to a tall building.

Buffalo, N. Y. J. J. TIMMONS

Efficiency and Its Cost

WE read *Power*, and, seeing all the new developments, we wonder and think to ourselves, "Surely a kilowatt-hour will soon be generated by some of our distinguished engineers for nothing." Most plants are paying too much for their power, and should get it for less now. At our plant, for example, we generate a kilowatt-hour for 7 mills and we have a very clean, well-balanced automatic plant of 2,500 kw. and 10,000 sq.ft. in boilers. We employ no air preheaters. We generate steam at 300 lb. and 250 deg. superheat. After generating power at 240 volts, we pass steam at 0 to 10 lb. backpressure to process. We burn coal, and efficiency averages 76 to 78% for a month continuously with 12% CO_2. Of course, boilers are well insulated and steel encased. We use sprinkler-type stokers and the power plant is really immaculate. Control is automatic; operators never touch anything except to clean it or to make some manual observation. Feedwater is controlled by tests twice daily, and we operate at 200% rating continuously with 250% rating peaks.

Olson Rug Co. WM. MICK
Chicago, Ill. *Asst. to Mech. Engr.*

Vibration of Boiler-Feed Pumps

WE HAVE experienced almost the same difficulty with a 4-stage boiler-feed pump under the same conditions described in May *Power*, page 288. In cleaning the lower casing, some deposits were probably loosened which stopped up the equalizer pipe carrying leak-off from the balancing device to stuffing box on the suction end. Test for this may be made by making a temporary connection from balancing-compartment air-bleeder cock to heater or sewer.

If the pump has a stopped equalizer or badly worn diaphragms, or both, opening this drain will relieve vibration. Stoppage of leak-off may be either in the equalizer pipe or in small openings of adjuster bushing on the suction end. Insufficient leak-off allows a metal to metal contact of balancing disk and seat and causes vibration and wear of parts.

If the balancing disk or seat is badly worn, it is very probable that diaphragms have not escaped damaging wear, as lateral clearances are extremely close. If diaphragms and impeller wearing rings are excessively worn, it may be found impossible to prevent rubbing of balancing-disk surfaces, because leakage back to suction through the diaphragms adds load to the balancing disk in addition to the normal thrust.

With a clear equalizer pipe and properly fitted diaphragms, the pump should not vibrate from rubbing of balancing surfaces.

Lincoln, Nebr. O. H. BRAND

Measuring Total Boiler Blowoff

CONCERNING the answers to the question on measuring total blowoff, July *Power*, the only positive way to know the amount of blowoff is to meter it. One type of meter uses a V-notch and measures waste as it runs from the blowoff tank into the sewer. Another is a revolving-disk meter which can meter the water under full pressure. The first of these meters is adapted for hand blowing and the other for continuous blowing.

Most power plants have a makeup-

water meter, and in a closed system where losses are small, blowoff can be estimated very closely from the makeup meter. Makeup-meter reading minus other losses equals the blowoff. The first of these two methods is exact and the second is very closely so, provided other losses are negligible or are known.

There are two other methods that are approximate and which use chemical means and calculations. One of these is based on the chloride ratio of the raw to feedwater. For example, if the raw-water chloride ratio is 10 and that of the feedwater 0.5, the total makeup water is 5 per cent, assuming that the chloride ratio of the pure condensate is zero. The difference between total makeup and other losses is the blowoff.

Another way is to determine chloride ratio of the boiler water before and after blowing. The "chloride" of the boiler water is first determined, then the boiler is blown, and the water level is brought to normal. After the water has mixed, a sample of boiler water is again taken and the chloride ratio determined. Since the "chloride" of the feedwater is relatively small compared with that of the boiler water, per cent of blow down is the same as the per cent of chloride reduction. For example, if the reading before and after blowing is 20 and 18 respectively, then the blowdown is 10 per cent, so that if the boiler contains 50,000 pounds of water, 5,000 pounds have been blown.

This last method is suitable for hand blowing while the chloride method is suitable for continuous blowing. If alkalinity of the water is greater than the salt, more accurate results can be obtained by using the alkalinity ratio.

Chicago, Ill. N. T. Pef.

More About Safety Values

AFTER reading the question and answer, "Why Are Safety Valves Required on Superheaters", page 289, May *Power*, the following points came to mind.

Assuming that the boilers in question were installed new in 1919 and were stamped with a water-heating surface of 1,500 sq.ft. (this stamping is located on the front head above the top row of tubes according to A.S.M.E. specifications), they would evaporate 5 lb. of water per sq.ft. of heating surface per hr., if operated at 125 lb. gage pressure. Therefore, one boiler would evaporate 5 × 1,500 or 7,500 lb. of water per hr., which is the total amount of steam that the safety valves must discharge per hr.

Paragraph P-267 of the 1935 A.S.M.E. Code states that a boiler with over 500 sq.ft. of heating surface, or evaporating more than 2,000 lb. of water per hr., must have two safety valves. In this case, each boiler would require two safety valves, and if valves were placed on one connection, the outlet should have a 4½-in. diameter, according to Table 15 of the A.S.M.E. Code.

Reverting to Appendix A-11 of the A.S.M.E. Code and using the formula for bevel-seated valves, we find that the amount of steam which a safety valve will discharge per hr. equals 110 × the pressure absolute × the valve diameter × the valve lift (assume 0.1 in.), or the diameter of the valve would equal the steam discharged per hr. divided by 110 × the abs. pressure × the valve lift, or

$$\frac{3750}{110 \times 139.7 \times .1} \text{ equals } 2.44 \text{ in.}$$

Therefore, a 2½-in. diameter bevel-seat valve would discharge 3,750 lb. of steam per hr., and both valves would discharge 7,500 lb. However, before installing these valves on one connection, check against Paragraphs P-278 and P-280.

The question does not state when the superheater was installed, so we should assume that the superheater may be removed from the boiler at some future time, and in that event, the two 2½-in. safety valves would suffice for the boiler.

If the superheater was installed with the boiler and there were no valves in the lines, the safety valve that is installed on the superheater outlet may be considered in calculating total discharging capacity of the safety valves. The A.S.M.E. Code allows 25% of the total boiler discharging capacity for a superheater valve, and so, on a new installation, it would be necessary to install a valve on the superheater that would discharge 25% of 7,500 or 1,875 pounds, which would reduce the discharging capacity of boiler safety valves to 5,625 lb. per hr.

It is stated that relieving capacity of the valve on the boiler is 10,600 lb. per hr., and it is therefore presumed that there is only one safety valve on each boiler, which seems contrary to the Code. An additional 1½-in. safety valve of the outside spring type with a discharge of 1,875 lb. of steam per hr. would be ample for each boiler superheater. The superheater safety valve should have a flanged inlet connection.

Should the superheater be removed from the boiler at any time, it would be necessary to install an additional safety valve directly on the boiler.

Buffalo, N. Y. J. J. TIMMONS

READERS' PROBLEMS

QUESTIONS for Our Readers

Size of Blowdown Tanks

Question 1

DO POWER *readers know of a rule that will determine definitely the proper size of a blowdown tank for high- and low-pressure boilers? I have looked through existing textbooks, but find nothing but good advice.*—G. H. H.

Removing Oil from Pipe Systems

Question 2

WE *have been operating a steam-engine plant exhausting into a low-pressure steam distributing system for heating and other purposes. Oil in the engine exhaust has made itself apparent in the low-pressure steam piping. In a few months we will put into service a 500-lb. plant, the turbine of which will exhaust into the old low-pressure distribution system. We want to use the condensate returns from this system as feedwater in the high-pressure boiler. Before doing so, it is necessary to make sure that piping is free from oil to avoid getting any of it into the high-pressure boiler. Have any* POWER *readers had experience with this sort of thing? The old engine plant is to be scrapped.*—H. G.

Suitable answers from readers will be paid for if space is available for publication.

LAYING UP STEAM TURBINES

Answers to July Question 1

The Question

WE *have two 200-kw. steam turbines that may be operated condensing or non-condensing. These turbines may be out of service for several months at a time and I would like to know how to treat them so that they will be properly protected against rust and corrosion and at the same time be ready for immediate service. Can* POWER *readers give me the benefit of their experience?*—W.O.R.

Thorough Conditioning of Turbine Imperative

TO BE READY for immediate service, a turbine must be kept at temperature of normal operation. While the unit is laid up, this cannot be accomplished with the assurance that there will be a total absence of moisture or corrosion. It is assumed that a warming up period is permitted.

Before laying up the turbine, open up the machine for internal examination. Remove all corrosion, scale and loose particles by brush and air blast. Before closing up the machine, condition all valves so that no trace of vapor will leak into the casing. Mix kerosene and graphite to a consistency of heavy paint and apply it with a soft brush

to the blading, wheels and shaft while they are still warm. Allow the machine to cool before closing up and thoroughly oil bearings and journals.

All drain lines to heaters, hotwell and other parts of the system, where vapor is present, should be bypassed and left open to the sewer while the unit is shut down. Fill the condenser with cold water above the level of top row of tubes to prevent drying out of packing. Turn the machine over by hand twice a week. Condensate and circulating pumps should be repacked during shut down and turned over regularly. With this treatment, the machine is at all times ready for immediate service after being warmed up. The small amount of kerosene and graphite passed into the system will be harmless.

Kearney, N. J. GEO. M. MCNALLY

Operating Experience

FIRST, see that there is no steam leakage through the turbine and that all stages are completely drained. To insure these conditions, install a separate drain between the throttle and emergency governor valve and leave the latter closed. Better still, provide two valves in the steam line with a drain between them. It is also advisable to carry stage and packing-gland drains separately to atmosphere.

Operate occasionally emergency governor trips and valves by hand to insure free action. We have operated three similar turbines with bronze buckets on the wheels and intermediates, bronze main nozzles and steel-diaphragm nozzles under conditions mentioned by W.O.R. for 15 years without injury.

Altoona, Pa. A. R. MARKLAND

CHATTERING OF D.-C. MOTOR BRUSHES

Answers to July Question 2

The Question

ON A *100-hp. d.c. motor in our plant, the brushes chatter badly. Paraffin applied to the commutator stops chattering only momentarily. Brush holders have been tried in positions where the commutator runs against the brushes and vice versa, without correcting the trouble. Temporary relief was obtained by turning down the commutator. How can this difficulty be corrected?*—J.P.M.

Grade of Brush May be Unsuitable

APPARENTLY J. M. P. is using brushes of improper grade. If the commutator is not undercut, it is essential to use carbon with abrasive qualities that will wear down the mica. It has been my experience that most brush troubles are caused by wrong grade of brush, too free use of lubricants, and too much spring tension.

Alternating hard and soft brushes in the holder will frequently produce the polished mahogany-colored commutator, which is an ideal condition. Brushes set in holders made of light sheet metal are more or less inclined to chatter. Brushes should closely fit holders, but still work freely. Set holders with but little space between them and commutator, undercut the mica and use graphite brushes.

Leesville, S. C. F. F. BRODIE

Lubrication Gives Only Temporary Relief

CHATTERING of brushes in d.c machines occurs usually when peripheral speed is high and box-type holders are used. Lubrication of the commutator offers temporary relief, but it is impossible to lubricate often enough to stop the noise completely. Chattering may happen with the commutator in good or bad condition. A clamp-type brush holder may rock at high speeds and cause sparking.

To remedy chattering with box-type holders, set the brushes so that their center lines form an angle of less than 10 deg. with the diameter of the commutator and their edges trail in the direction of rotation .

Houston, Tex. E. G. SCHEER

Rules for Adjusting Brushes

TO ELIMINATE brush chattering, set brush holders as close as possible to the commutator. This not only permits more accurate spacing of brushes, but short leverage so obtained prevents chattering. Fit brushes in the holders with as little clearance as possible and yet leave them free to move.

Brushes should contain some lubricant. See that tension is not out of the springs, and that they hold brushes to the commutator with a pressure of about 2 to 2.5 lb. per sq.in. of brush contact.

Oelwein, Iowa JAMES A. WELCH

Brush-Holder Design and Setting are Important

BECAUSE turning down the commutator gave temporary relief, it is probable that bars did not stay in place. This may be due to a loose commutator assembly or warping caused by overheating, or both. Tighten commutator spider bolts, then turn and dress the commutator to a smooth surface. Undercutting should be done by an experienced man (preferably a vee cut). Excessive heating can be avoided by selecting a good grade of unimpregnated, non-abrasive, electro-graphitic brush.

Brush-holder design and setting are very important factors in eliminating brush chatter. Reaction-type holders give the most satisfactory performance when set at a 30-deg. leading angle from the radial position. Brush tops should be beveled to a 20-deg. angle so that spring pressure will hold them securely against the holder seat. With this design of holder, satisfactory results are obtained with a spring tension of proximately 1.5 lb. per sq.in. of brush face.

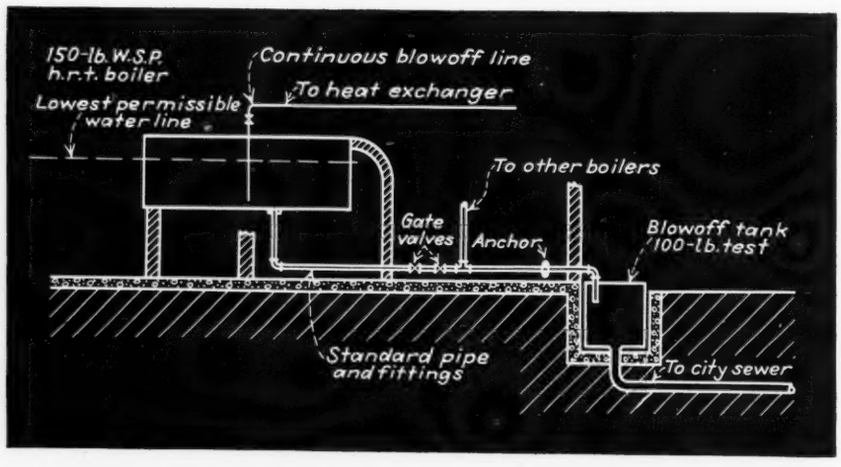
In one case, two 100-kw. d.c. generators operated with excessive brush chatter and would not carry full load because of commutators overheating. Satisfactory operation, using approximately half the number of brushes originally prescribed for the machine, was obtained by following the suggestion given above. Overloads are now maintained on the machines for indefinite periods without sign of chattering or overheating of the commutator.

In connection with undercutting of commutators, attention is invited to an article by the writer, in the May, 1931

WHAT'S WRONG WITH THIS PICTURE?—XVII

Boiler Blowoff System

At least 14 errors are shown in this drawing. Make a list of those you recognize, then compare with the list on page 527



Journal of the American Society of Naval Engineers.

New York, N. Y. C. HUEY
Senior Material Eng., U. S. Navy Yard

Box Holder a Chief Offender

BRUSH chatter may be caused by worn bearings; too much clearance in box-type holders and slow spring action; wrong brush angle; and commutator distortion caused by heat.

Chatter occurs frequently on motors that have box-type brush holders with a flat spring holding the brush to the commutator. If it is possible to set holders so that the center line of the brushes makes an angle of 8 to 10 deg. with a straight line drawn through the center of the commutator, and set brushes pointing in the direction of rotation, chatter will probably cease.

Bearings may have more clearance than necessary, which may cause vibration, especially if the armature is not perfectly balanced. Brush springs cannot react fast enough for this vibration, and chatter results. If the commutator distorts or bars get high under heat, sparking usually results. The remedy is to true the commutator when it is hot.

Dorchester, Mass. W. F. O'REGAN

Six Causes of Brush Chattering

SINCE J. P. M. uses paraffin, I assume that the motor has flush mica and operates with radially-set brushes. We had similar trouble on some d.c. motors in our stations which had the same brush-holder design. We eliminated chattering by undercutting the commutator, arranging the brush-holders so that brushes pointed against the direction of rotation, designing the brushes with a 37½-deg. angle at commutator face and a 15-deg. bevel at the top where the pressure arm contacts. In addition, we used a brush of low contact drop.

Besides eliminating chattering, commutation improved and a 50% increase in brush life was obtained with a material decrease in commutator maintenance cost. From experience on various units in our plants, the most common causes of brushes chattering are:

1. Improper angle of brush on the commutator.
2. High-friction brush causing excessive commutator temperatures.
3. High mica or high commutator bars.
4. Flat spots on the commutator.
5. Rough or smudgy commutator.
6. Brush-thickness tolerances larger than required, causing brushes to fit loosely in holders. Only a tolerance sufficient to keep the brush from sticking in the holder when the unit operates at its continuous maximum-load temperature is necessary.

Tenafly, N. J. K. B. HOFFMAN

WHAT'S WRONG WITH THIS PICTURE?—~~XVII~~ XIX

Boiler Blowoff System—See page 526

1. *Blowoff connection on boiler improperly located.* H. R. T. boilers should be set so that there is a slight slope from front to rear. The blowoff nozzle should be as near the back head as possible to insure removal of all sediment accumulating.

2. *Blowoff pipe in combustion chamber not protected.* This pipe should be guarded against direct flame action by a tile casing.

3. *Pipe and fittings of insufficient strength.* The A.S.M.E. Boiler Code states that this piping should be at least extra heavy. In the great majority of installations, steel fittings are used up to the blowoff valves.

4. *Two gate valves used as blowoff valves.* While a gate valve may be used as the outside or guard valve, a globe or other positive-closure type should be installed next to the boiler.

5. *No provisiion for expansion in blowoff line.* With an anchor as shown and no expansion swing joints or bends the full line expansion acts against the boiler blowoff nozzle. This connection should be relieved of all such strains.

6. *Continuous blowoff sampling pipe extends below the lowest permissible water line.* This is not good practice because in the event of a line rupture or feed interruption, flow through this line may cause a low water condition.

7. *No excess-flow check valve provided in this line.* It is good practice to provide such a valve for the reasons given above.

8. *Only one valve shown in continuous-blowdown line.* At least two valves placed as near the boiler as possible should be used on all blowoff lines.

9. *No vent on blowoff tank.* The primary purpose of a blowoff tank is to reduce the velocity, pressure, and temperature of the incoming blowoff water. Without a vent for the flashed steam it would go directly to the sewer, with possibly dangerous complications.

10. *Incoming blowoff line to tank designed improperly.* To reduce the velocity of the incoming water as much as possible, this line should enter tangentially and spiral downward.

11. *No provision for cooling blowoff water.* Most city ordinances require that this water be cooled well below the boiling point before entering the sewer.

12. *No cleanout or inspection opening in blowoff tank.* Such an opening should be provided so that internal inspections and repairs can be made.

13. *No drain at bottom of tank pit.* A drain should be provided or the pit will fill with water or refuse and corrode or interfere with free expansion of the tank.

14. *Blowoff tank insufficiently strong.* A 150-lb. test tank should be used.

New York, N. Y. S. H. COLEMAN

Horsepower Stored In a Flywheel

WHAT *horsepower is stored in a 10-ft. flywheel, weight 10 tons, velocity 6,000 ft. per min.?*—R.M.B.

AS STATED, the question cannot be answered for several reasons. First, a flywheel stores *energy*, not *power*. A given flywheel, running at a given speed, will deliver any desired horsepower, according to how quickly it is stopped. The quicker it is stopped the more power it will deliver (but for a shorter time). What the flywheel stores is *energy*, measured in ft. lb., horsepower seconds (not horsepower per second), horsepower minutes or horsepower hours, all of which are measures of energy.

The question does not specify the arrangement of weight in the wheel. To answer the question it is assumed that the entire weight of the wheel is in the rim and that the 10 ft. diameter is measured not to the outside of the rim but to the center (approx.) of its cross section. Then the stored energy in foot pounds is $W V_2 \div 2 g$, where W is the weight in pounds, V is the velocity of the center of the rim section in ft. per sec., and g is 32.2, the acceleration of gravity. We then have:

Energy $= (20{,}000 \times 100) \div (2 \times 32.2) =$ 3,100,000 ft. lb. Since one hp. equals 550 ft. lb. *per second*, this energy would deliver for one second a power of 3,100,000 ÷ 550 = 5,640 hp. For one minute power would be 3,100,000 ÷ 33,000 = 94 hp.

Fuel Saving from An Economizer

WHAT IS *the present fuel saving from the installation of an economizer? Steam pressure is 200 lb. gage. Inlet temperature 150 F., outlet temperature 290 F.*—R. M. B.

CARRYING the answer to the nearest B.t.u. only:

h_2 = heat in water leaving = 259 B.t.u.
h_1 = heat in water entering = 118 B.t.u.
H = heat in steam produced = 1199 B.t.u.

Before economizer is installed, heat to produce one lb. of steam in boiler is 1199 — 118 = 1081 B.t.u. After economizer is installed heat to produce one lb. of steam in boiler is 1199 — 259 = 940 B.t.u. Saving is 1081 — 940 = 141 B.t.u. Practically the same figure (this time 140) is obtained by simply taking the difference between the entering and leaving temperatures.

For a given amount of steam produced, the saving in coal, expressed in per cent, will be $(141 \div 1081) \times 100 = 13.0\%$. The same result is obtained by the formula:

$$\% \text{ saving} = 100 \times \frac{h_2 - h_1}{H - h_1}$$

MANUFACTURER'S BULLETINS

Air Conditioning—Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Condensed catalog, "The Modutrol System of Air-Conditioning Control", has following sections: 16 pages on automatic controls, 50 pages on typical control systems; 15 pages on control circuits; 26 pages on residential conditioning systems; 26 pages on outdoor compensators, and 16 pages of engineering data—charts, tables and diagrams. Contains much useful operating data besides usual equipment descriptions.

Air Heater—James Campbell Smith, Inc., 16374 Euclid Ave., Cleveland, Ohio. 4-page bulletin describes automatic coal-fired unit for air heating and conditioning. Illustrations and cross-sectional drawing show operation and construction.

Air Eliminator—Gorton Heating Corp., Cranford, N. J. 2-page folder on air eliminator for automatically venting driers, steam coils, traps, etc., under operating pressures up to 150 lb.

Automatic Controls—Mercoid Corp., 4201 Belmont Ave., Chicago. 16-page catalog describes thermostats, "Pyratherm" oil-burner control, pressure-limit and low-water controls for steam boilers, hot-water and warm-air temperature controls, and mercury-contact switches. Full page illustrations; also inserted are small folders giving specifications for each type of equipment.

Bearings & Bushings—Johnson Bronze Co., New Castle, Pa. Wall reference chart gives complete information on over 200 sizes of cast-bronze graphited bearings with data on applications, tolerances and alloys.

Bearings—Fast Bearing Co., Hampden Ave. and 23rd St., Baltimore, Md. 16-page catalog lists specifications, dimensions of new "precision oil-film" bearing. Construction and tests made illustrated with photos.

Blowers and Compressors—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin on rotary, centrifugal and reciprocating compressors and blowers. Each different type described and illustrated, and principal applications listed.

Boiler-Feed Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page Bulletin W-318-B7A describes new line of multi-stage centrifugal boiler-feed pumps for pressure up to 1,200 lb. per sq. in. 4-, 6- and 8-in. sizes for speed range of 2,500 to 4,000 r.p.m.; 200 to 1,500 g.p.m.

Boilers—Combustion Engineering Co., 200 Madison Ave., New York, N. Y. 16-page Catalog N-5 describes and illustrates "C-E Nuway" fire-tube boiler, which has special arrangement of tubes and baffles to provide definite circulation path. Shows construction details, setting drawings and tables of dimensions, and how to attach superheater.

Centrifugal Pumps — Morris Machine Works, Baldwinsville, N. Y. Bulletin 164 on double-suction, horizontally-split centrifugal pumps. Rating table and line drawings show mechanical efficiency of this unit.

Compressors—Worthington Pump & Machinery Co., Harrison, N. J. 8-page Bulletin L-612-B5 on single-cyl., single-stage, air- and water-cooled compressors. Specifications, rating and dimension tables. Illustrations show units coupled to vertical or horizontal air receiver, direct-connected to motor and gasoline engines, and 3- and 6-cyl. angle-type 2-stage units in various arrangements.

Compressors—Worthington Pump & Machinery Corp., Harrison, N. J. 20-page bulletin No. L-612-B3 describes horizontal steam-driven compressors with constructional features and applications. Well illustrated.

Condenser and Heat-Exchanger Tubes—Scovill Mfg. Co., Waterbury, Conn. Base price list (March, 1937) on condenser and heat-exchanger tubes in cents per lb.

Condensate Meter—Central Station Steam Co., Detroit, Mich. 12-page catalog No. 20 lists applications, types and sizes, and construction of "Cadillac" condensate meter, which has main use in district-steam plants.

Condensate-Return Pumps—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Bulletin No. 1972-B illustrates "Cameron" motor-pump condensate-return unit and its applications. Specifications, sizes and capacities.

Copper Convectors—Young Radiator Co., Racine, Wis. 24-page catalog No. 4037 on all types of "Streamaire" convectors. Rating charts and diagrams, cross-sectional drawings, and piping diagrams.

Corrosion of Cast Iron—International Nickel Co., 67 Wall St., New York, N. Y. 6-page reprint, "Some Consequences of Graphitic Corrosion of Cast Iron," from *Metals and Alloys*, Dec., 1936.

D. C. Motors—Century Electric Co., 1806 Pine St., St. Louis, Mo. 8-page Bulletin 1033 describes construction and operation of d. c. motors, 1 to 300 hp.

Diesels—American Locomotive Co., 30 Church St., New York, N. Y. 4-page bulletin describes Type T Alco-Sulzer 2-cycle diesel, various component parts, lubrication, fuel system, and exhaust and scavenging. Rating and dimension tables; line drawings show method of operation.

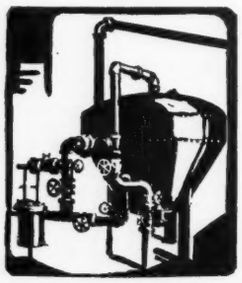
Diesels—Cummins Engine Co., 220 Wilson St., Columbus, Ind. A magazine-catalog, "The Dependable Diesel", illustrates Cummins' installations and applications. Many photos and drawings.

Expansion Joints—Foster Wheeler Corp., 165 Broadway, New York, N. Y. Mailing folder No. X-37-4 describes Type S stainless-steel, bellows expansion joint for pressures up to 150 lb. per sq. in. Application, construction, services and materials.

Feedwater Heaters—Elliott Co., Jeannette, Pa. 30-page pictorial bulletin No. D-4 illustrates uses and applications of various types of feedwater heaters, including open spray and tray, deaerating thoroughfare and metering heaters.

Flexible Enamel—Roxalin Flexible Lacquer Co., Inc., Elizabeth, N. J. Mailing folder on cellulose-type, air-drying, flexible lacquer enamel. Said not to chip, flake or peel, and to stand blanking and forming.

Fuses—Trico Fuse Mfg. Co., Milwaukee, Wis. Folder No. 3700-CB points out how costly wasted kilowatts are and how "Trico Powder-Packed" renewable fuses and clamps may eliminate this loss.



Ground Resistance—James G. Biddle Co., 1211–13 Arch St., Philadelphia. 8-page Bulletin 1500 describes "Megger" instruments for measuring resistance of ground. Applications shown in industrial and utility fields.

Laboratory Instruments—Ace Glass, Inc., Vineland, N. J. 142-page catalog lists prices, construction, operation and method of assembly. A complete list of glassware for every possible need. Ground-glass connections.

Materials Handling—Lewis-Shepard Co., 175 Walnut St., Watertown, Mass. Mailing folder on skid platforms for conveying material by lift-truck method of interior transportation. Folder 146.

"Neoprene"—E. I. duPont de Nemours & Co., Wilmington, Del. Booklet describes synthetic rubber product which resists deteriorating efforts of oil, chemicals, etc. Lists specific applications and shows method of manufacture.

Oil and Gas Burners—Engineer Co., 17 Battery Place, New York, N. Y. Bulletin OB-37 describes complete line of oil-burning equipment under trade name "Enco," including steam- and mechanical-atomizing units, combination burners, and fuel-oil pumping and heating systems.

pH Recorders and Controllers—Leeds & Northrup Co., 4906 Stenton Ave., Philadelphia. 20-page illustrated bulletin, "To Improve Corrective Water Treatment," describes compact electrode assembly which automatically detects pH of a continuously flowing sample of boiler feedwater or makeup. Standard "Micromax" unit indicates and records pH, and may be used to automatically control reagent input.

Piping—Key Co., East St. Louis, Mo. Mailing folder on traveling reconditioning service (mobile truck-drawn shop) for return-bend fittings.

Portable Combustion-Testing Instruments—Hays Corp., Michigan City, Ind. 18-page Bulletin 37-253 describes portable flue-gas analyzers, draft gages, flue-gas thermometers, combustion test sets, and b.t.u. calorimeters. Method of operation and construction illustrated.

Power Equipment—Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. 48-page condensed catalog No. G-2-B lists all equipment made by this company and Babcock & Wilcox Tube Co., Beaver Falls, Pa. Included are complete boiler units, waste-heat boilers, superheaters, economizers, air heaters, furnaces, piping, castings, burners, pulverizers, etc. Completely illustrated with line drawings, and application photos.

Pressure-Regulator Selector Chart—Davis Regulator Co., 2540 Washtenaw Ave., Chicago, Ill. Illustrated chart designed to provide quick selection of pressure-reducing valves for any kind of service on steam, gas, air, oil, or water.

Pumps—Quimby Pump Co., 340 Thomas St., Newark, N. J. 8-page bulletin on "Rotex" pumps for viscous and semi liquids at discharge pressures up to 200 lb. per sq. in. and capacities up to 500.

Pumps—Yeomans Brothers Co., 1433 Dayton St., Chicago, Ill. 16-page illustrated catalog on pumps for drainage, sewage, water supply, circulation, boiler feed, condensation and air conditioning. Mostly a description of each type of pump and its uses.

Pyrometers—Brown Instrument Co., Philadelphia, Pa. 40-page Catalog 15-C covers line of Brown millivoltmeter pyrometers—indicating, recording and controlling. Also describes moisture-proof rotary switch, multiple key-switch, control relays, valve mechanisms, thermocouples and accessories.

Pyrometers—C. J. Tagliabue Mfg. Co., Park and Nostrand Ave., Brooklyn, N. Y. Illustrated Catalog 1101C on "Celectray" high-speed, photoelectric-action pyrometers. Specifications and applications.

Refrigerating Units—Frick Co., Waynesboro, Pa. Bulletin 97-C describes low-pressure refrigerating units in 50 types and sizes, with motors ¼ hp. and up. Shows principal applications and range of service.

Self-Locking Nuts and Bolts—Dardelet Threadlock Corp., 55 Liberty St., New York, N. Y. 4-page folder describes operation and principle of self-locking screw thread. Applications table of thread data.

Silent Gears—Continental-Diamond Fibre Co., Newark, Del. 8-page bulletin describes silent gears made of "Celoron", a laminated plastic. Tables on gear-tooth data, horsepower rating per in. of face, and speed.

Steam Traps—Warren Webster & Co., Camden, N. J. Illustrated bulletin 1200-C on "Series 78" steam trap. Describes operation in detail, methods of application. Dimension tables, rating charts, and application photos. 32 pages.

Switchgear—General Electric Co., Schenectady, N. Y. 18-page catalog, "Modern Switchgear", shows all types of circuit breakers, switches, switchgear, and relays. Each item illustrated and important operating features described.

Turbines—DeLaval Steam Turbine Co., Trenton, N. J. 4-page pamphlet describes a geared-turbine pumping unit at Louisville, Ky., during last Winter's flood. Stresses rapid reconditioning and sturdiness of the pumping unit.

Unions—E. M. Dart Mfg. Co., Providence, R. I. 12-page illustrated catalog gives information on types, sizes and prices. Full-color illustrations shows full-bearing, ball-joint construction of Dart unions.

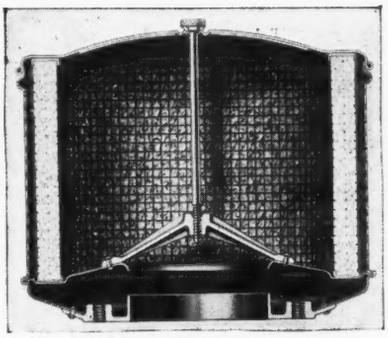
Valves—American Schaeffer & Budenberg Div., Consolidated Ascroft Hancock Co., Inc., Bridgeport, Conn. 24-page bulletin on diaphragm motor valves. Various types described and illustrated; air, gas, steam and liquid capacity charts.

Vibrating-Reed Tachometers — James G. Biddle Co., 1211-13 Arch St., Philadelphia. 12-page Bulletin 1510 shows operation and construction of recently-developed vibrating-reed tachometer. Price and specification lists, and four pages of application photos.

Water Meters—Worthington Gamon Meter Co., Harrison, N. J. Bulletin M-975-B34 describes 3- and 4-in., heavy-duty disc meters for either circular or straight reading. Dimensions, cross-sectional drawings, and pressure-loss chart.

Welders—Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa. Application, construction, specifications and performance curves for single-operator, 200-, 300- and 400-amp. motor-driven welders.

WHAT'S NEW IN PLANT EQUIPMENT



INDUSTRIAL AIR CLEANER

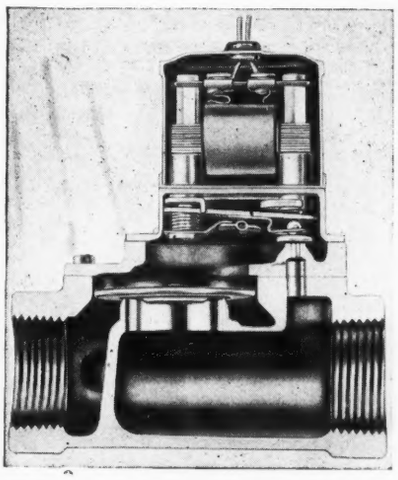
"I-F SERIES" air cleaner, for removing dust from intake of gas or diesel engines, compressors and pumps, has filter of wound copper gimp coated with viscous fluid. As intake air flows through winding, air is forced into repeatedly changing passes; dirt and grit clinging to oily surfaces. Large gimp windings provide several weeks of operation without rechanging. Filter unit may be removed for cleaning and recoiling. Capacities up to 3,150 c.f.m. at maximum velocities of 4,000 f.p.m.

Burgess Battery Co., Acoustic Div., 111 W. Monroe St., Chicago, Ill.

STAINPROOFING AND WATERPROOFING FOR BUILDINGS

"SUPER-POR-SEAL" applied to clean, dry concrete, stucco or masonry surfaces as a check against staining and efflorescence of buildings. May be applied with brush or spray apparatus. Covering capacity of 150 to 200 sq.ft., one coat, or 80 to 100 sq.ft., two coats.

Truscon Laboratories, Detroit, Mich.



MAGNETIC GAS VALVE

SMALL DISK floats in chamber. When control instrument through electromagnet lifts bleeder valve, pressure above disk is released to downstream side. Incoming gas then lifts floating disk to top of chamber, and as long as bleeder valve is open, disk is held up. When control instrument is satisfied, relay closes bleeder valve in a fraction of a second. Bronze valve body, aluminum floating disk, and leather seats on floating and bleeder valves: 6-volt a.c. current.

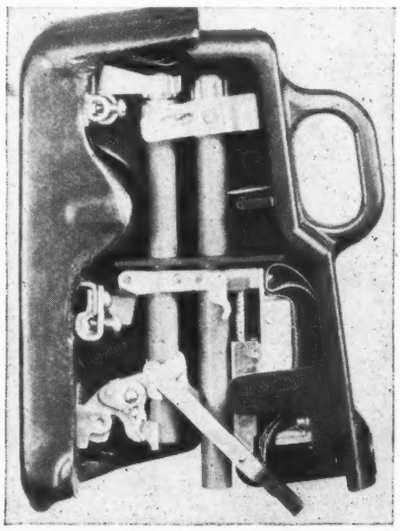
Julien P. Friez & Sons, Inc., Baltimore, Md.

HEAVY-DUTY HEX-BOX WRENCHES

HEAVY-PATTERN wrenches have heads of approximately same thickness as nuts they serve. Openings range from 1¼ to 3/8 in. Dropforged in two lines: carbon

steel and chrome-molybdenum "superrenches." Carbon wrenches finished in black enamel; "superrenches" chrome plated with faces buffed bright.

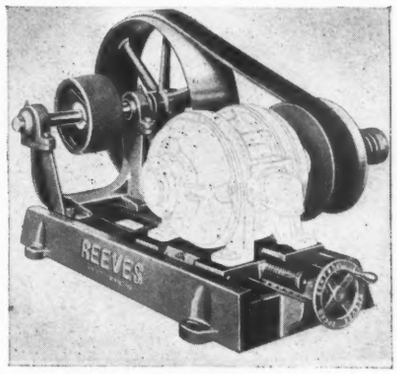
J. H. Williams & Co., 75 Spring St., New York, N. Y.



RECLOSING FUSE CUTOUT

RECLOSING door of unit contains two fuse holders. Should first fuse link blow, door is pushed outward at bottom. After time lag of one sec., other fuse holder with its link is connected, thus restoring service if fault is temporary. Should second fuse blow, complete door drops open and is isolated from circuit. If fault still persists, or when another short circuit occurs before blown fuse link is replaced, inner fuse will blow, releasing toggle mechanism and permitting door and fuse holder to drop to open position. Rated 50 amp., 5000 volts and 7500/12, 500 grounded Y volts.

General Electric Co., Schenectady, N. Y.



VARIABLE-SPEED MOTOR PULLEY

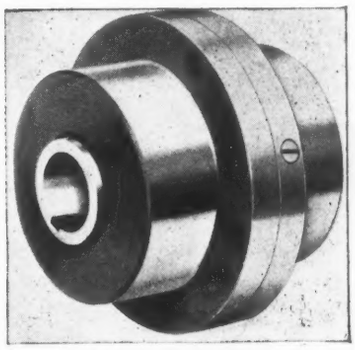
VARIABLE-SPEED unit is mounted on standard shaft extension of constant-speed motor. Through handwheel control, sliding base on which motor and unit are mounted is moved forward or back, varying diameter of a set of adjustable disks from which V-belt runs to driven machine. Desired speed changes are made as belt runs from maximum to minimum disk diameters. 7 sizes, from fractional to 7½ hp.; speed ratios of 3 to 1.

Reeves Pulley Co., Columbus, Ind.

TIME RECORDER

"CHRONOLOG" an instrument which provides printed record of productive and down time on any machine or operation, and may also show causes and extent of idle time and a count of units produced.

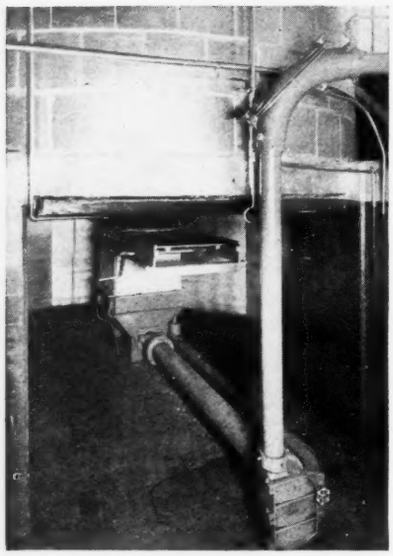
National Acme Co., 158 East 131st St., Cleveland, Ohio.



FLEXIBLE COUPLING

"RYBECK" flexible coupling, full-floating, semi-universal joint, transmits torsional load through groups of Sweedish-steel laminated springs confined in a housing to eliminate all motion except deflection. Alloy-steel driving pins, heat-treated, are pressed into steel hubs and fit into holes drilled into torque sleeves, held in alignment by housing. For extreme conditions encountered in direct drives.

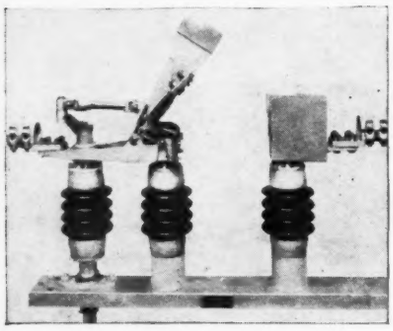
T. L. Smith Co., 2813 N. 32nd St., Milwaukee, Wis.



PNEUMATIC SPREADER STOKER

BIN-FEED stoker conveys coal by high-velocity air from bunker to boiler. Bunker may be located 8 to 15 ft. from boiler. Burns successfully coal of high ash content and of low ash-fusion temperature. Flat grates; moving parts not exposed to furnace temperature.

Iron Fireman Mfg. Co., 3170 W. 106th St., Cleveland, Ohio.



DISCONNECT SWITCH

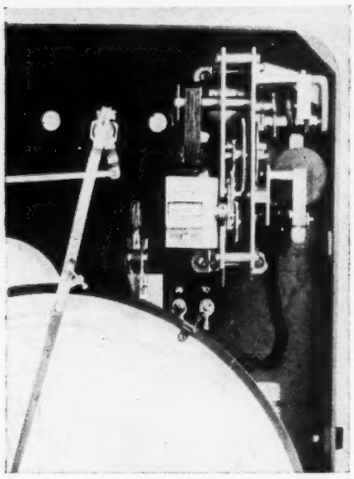
3-POLE, 15-kv., 1200-amp. manual- or motor-operated switch for inverted mounting. Two fixed and one rotating insulator have flashover values of 85 kv. dry, 50 kv. wet. Rotating ball-bearing blade first raises to parallel position, then changes to a lateral movement and enters fixed full-floating contact.

Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

ELECTRIC INTEGRATOR FOR FLOWMETERS

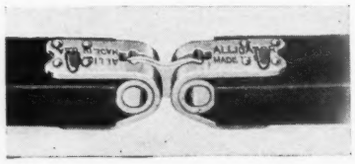
THIS UNIT totalizes flow once every 15 sec. of a gas or non-viscous liquid through a closed line. A flat-disk cam, designed to coincide with flow law, mechanically computes square root of differential pressure across an orifice plate or venturi tube in a pipeline. Values obtained are totalized by a counter and indicated on 6-figure dial. A continuous telechron motor operates counter through a train of gears, which are engaged and disengaged by mercury switch and magnet. Cam rider, connected through link to recorder pen arm, operates mercury switch in one direction while on cam and allows it to return to its original position when off cam.

Bristol Co., Waterbury, Conn.



V-BELT FASTENER

"ALLIGATOR" V-belt fastener joins together C-section V-belts of fabric-core, cross-weave construction. Alloy-steel rocker pin supported in bronze bushings.



Special method holds end plate to belt end without weakening belt or bulging its sides. No metal touches pulleys.

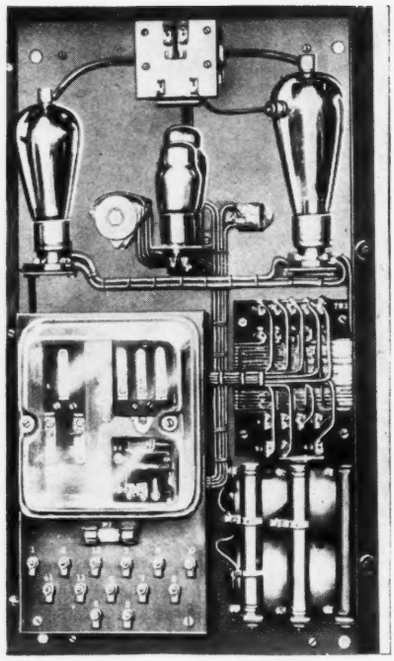
Flexible Steel Lacing Co., Chicago, Ill.

AUTOMATIC POWER UNIT

HEAVY-DUTY, high-compression 4- or 6-cyl. gas engine with flat-bed mounting, sheet-steel enclosure, centrifugal built-in governor, and gas carburetor are all conventional. Clutch and power take-off, however, have special vacuum operating mechanism that permits engine to start and attain full governed speed before load is applied; will also de-clutch if overload tends to reduce engine speed below predetermined limit. Control box contains master switch, safety switches and time-cycle switch.

Top oiler lubricates upper piston rings and cyl. walls; thermostat maintains cooling water temp.

Waukesha Motor Co., Waukesha, Wis.



ELECTRONIC VOLTAGE REGULATORS

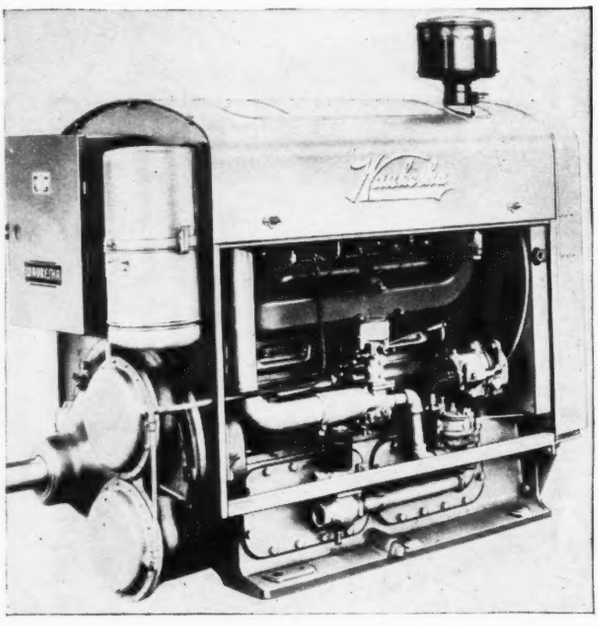
TWO MODELS, 5601 and 5602, are controlled rectifiers deriving power from a.c. generator and delivering rectified d.c. current to shunt field of exciter in an amount which is a function of a.c.-generator potential. No moving parts; stream of electrons controls regulating action. Corrective action of regulator 5601 starts within 1/120th sec. of slightest change in generator voltage; regulator 5602 within 1/60th sec.

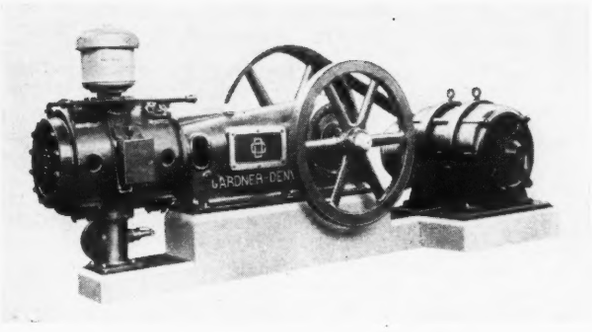
Ward Leonard Electric Co., Mt. Vernon, N. Y.

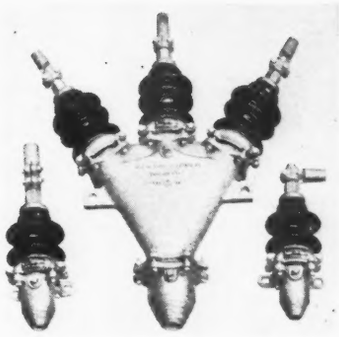
DUST AND BLOWER HOSE

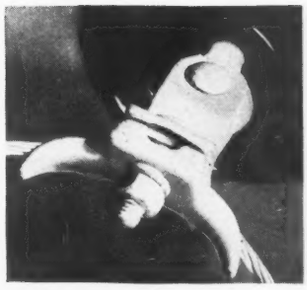
FOR protection against lung disease of silicosis. Carcass of hose supported by steel-wire helix and finished with outside corrugations to lend flexibility. Made in three thicknesses of pure gum tube; size range of 2 to 12 in.

U. S. Rubber Products, Inc., 1790 Broadway, New York, N. Y.









HEAVY-DUTY AIR COMPRESSOR

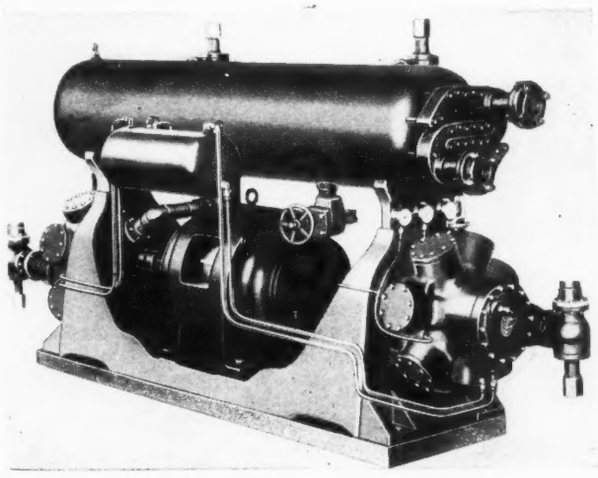
FOR heavy-duty, full-load service, single-stage horizotal "R.X." compressor has enclosed dust-proof construction. "Electro-Pneumatic" control starts compressor when unloaded and automatically adjusts air supply to fit load for economical part-load operation.

Gardner-Denver Co., Quincy, Ill.

MIDGET A.C. WELDERS

CURRENT range of 30 to 140 amp. with 12 steps of current adjustment. Secondary open voltage is 50 on low range and 55 on high. Primary current input for 140-amp. welding is 70 amp. at 110 volts and 35 amp. at 220 volts. For coated electrodes from 1/16- to 5/32-in. diameter. 60-cycle set weighs 112 lb., 50-cycle set 130 lb. Operating efficiency of 87% at normal loads.

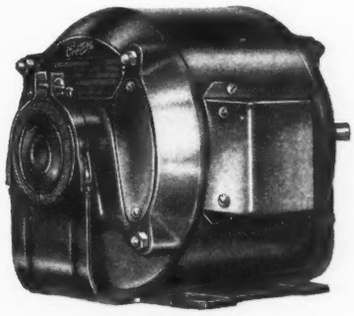
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.



BUSHING-CABLE TERMINATORS

FOR 7.5 to 30 kv., these terminators are designed to insure vacuum tightness under extreme conditions. Interchangeable stud connectors of hexagon hard-drawn copper rod; seating shoulders of laminated spring-bronze engage recesses in hexagons. When cap nut is tightened, laminations flex and press hood-nut gasket, compensating for temperature changes.

Delta-Star Electric Co., Chicago, Ill.



FRACTIONAL-HORSEPOWER MOTORS

SIZE range of 1/6 to 3/4 hp. Repulsion-start induction, single-phase, split-phase, capacitor, polyphase, and d.c. Interchangeable mounting dimensions for a given horsepower size.

Century Electric Co., St. Louis, Mo.

RADIAL COMPRESSOR FOR AIR CONDITIONING

SEVEN compressing cylinders are arranged in a circle around crankshaft. Balanced construction; operating speeds up to 1,750 r.p.m. Built in sizes of 10 to 75 hp. Lightness and compactness permit installation in any part of a building. Large valve areas combined with small lift provide quiet operation. Auxiliary intake ports, opened by piston as it completes downward stroke, accelerate intake said to be vibrationless.

Airtemp, Inc., Detroit, Mich.

ANGLE CLAMP

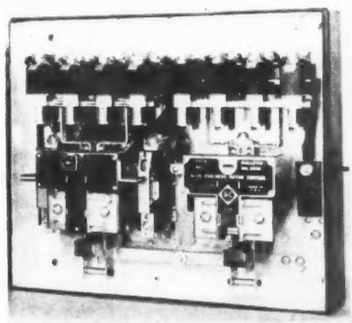
FOR distribution and industrial-plant lines, this clamp permits angles of 30 to 120 deg. to be turned without dead-ending conductors and using jumpers. May be attached to an eye, clevis or hook-type suspension insulator without intermediate fittings. Clamp body and keeper piece of malleable iron, hot-dip galvanized.

Ohio Brass Co., Mansfield, Ohio.

CENTRIFUGAL COOLANT PUMP

IMPELLER, open, double-suction type, hydraulically balanced to eliminate end thrust, is mounted directly on large-diameter extended motor shaft. Pump casing is cast intregal with motor support, at top of which motor is held in position with male and female lock to insure aligment. Built only in ¾-in. size for circulation of coolants, cutting compounds, or similar liquids containing abrasives in suspension. Capacities up to 30 g.p.m.; heads up to 19 ft.

Goulds Pumps Inc., Seneca Falls, N. Y.



REVERSING MOTOR STARTER

TYPE AP–7–R, 7½ hp., 550 volts, or less, has two motor-starter units mechanically interlocked so that one unit cannot be closed if other is closed. Starter units have enclosing chambers which confine and depotentiate arc formed by circuit interruption. Large silver double-break contacts, solenoid vertical make-and-break, individual molded pole units on steel chassis, and enclosed temperature overload relays to give positive motor protection.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

MODEL MOTOR

Though this appears to be a concrete model of a motor, it's a real one incrusted with a combination of rust and crystals, the latter from vapor of liquid chlorine handled in this plant. This 5-hp., 1750-r.p.m., totally - enclosed, self-cooled Allis-Chalmers motor has been in operation 5 years and shows the difficult conditions which modern electrical equipment must withstand for long periods of time

POWER LINES

$4,000,000 Addition for New Jersey Public Service

New Jersey Public Service Electric & Gas Co. will spend approximately $12,000,000 for enlargement and improvement of electric generating and transmission facilities in southern New Jersey.

The extensive program calls for an addition to the Burlington station to house a 100,000-kw. turbo-generator, two high-pressure, high-temperature boilers and accessories. The new turbine will exceed by 10,000 kw. the system's present largest unit, the 90,000-kw. generator at Kearny. The proposed installation will about triple the capacity of the Burlington station, bringing it up to a total of 151,750 kw.

A new dock, equipped with latest coal-handling facilities, will be built on the Delaware River at Burlington to make possible delivery of coal by water as well as by rail. A tower and conveyor belt system will be used to unload barges and carry the coal into storage piles.

A. Ch. S. Will Meet September 6–10

The 94th meeting of the American Chemical Society will be held in Rochester, N. Y., Sept. 6-10. Seventeen professional divisions of the society have scheduled sessions, to include a half-day symposium by the Industrial and Engineering Chemistry Div. on unit processes and automatic control.

Characteristic properties and chemical utilization of hydrocarbons will be the chief subjects of the Petroleum Div. Two days will be devoted by the Gas and Fuel Div. to gaseous combustion, which will include kinetics of ignition, flame propagation, inflammation limits, internal combustion engines, problems in fuel rating, and the state of burned gas.

MEETINGS

American Welding Society—*18th Annual Meeting and Exposition, Oct. 18–22, Hotel Traymore and Convention Hall, Atlantic City, N. J. Miss M. M. Kelley, secretary, 33 W. 39th St., New York, N. Y.*

American Society of Mechanical Engineers—*Fall Meeting, Oct. 4–6, Erie, Pa. C. E. Davies, secretary, 29 West 39th St., New York, N. Y. Also A.S.M.E. Annual Meeting, Dec. 6–10, New York, N. Y.*

A.S.M.E. and A.I.M.E. Fuels Conference—*Joint Meeting, Oct. 27–28, Pittsburgh, Pa. C. E. Davies, A.S.M.E. secretary, 29 West 39th St., New York, N. Y.*

Chemical Industries—*Sixteenth Exposition, Dec. 6–11, New York, N. Y. Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.*

Chicago Exposition of Power & Mechanical Engineering, *International Ampitheatre, Chicago, Ill., Oct. 4–9. Address Charles F. Roth, vice-president of International Exposition Co., Grand Central Palace, New York, N. Y.*

Heating, Ventilating and Air Conditioning—*Fifth International Exposition, Jan. 24–28, 1938, New York, N. Y. Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.*

Iron & Steel Exposition—*Sponsored by Association of Iron and Steel Engineers, Sept. 28-Oct. 1, Hotel Stevens, Chicago, Ill. Brent Wiley, Managing Director, Empire Bldg, Pittsburgh.*

National Association of Power Engineers—*Mississippi Valley Mechanical & Electrical Show, and 55th Annual N.A.P.E. Convention. Aug. 30 to Sept. 3. Jefferson Hotel, St. Louis, Mo. Fred C. Laufketter, chairman of Executive Committee, N.A.P.E., in charge.*

National Safety Council—*Annual Meeting, Oct. 11–15, Kansas City, Mo. W. H. Cameron, secretary and managing director, 20 N. Wacker Drive, Chicago.*

40,000-Kw. Unit for Providence, R. I.

United Engineers & Constructors, Inc., has been awarded a contract at $4,000,000 by Narragansett Electric Co. to increase the generating capacity of the Manchester St. Station in Providence, R. I.

Combustion Engrg. Co. will supply the high-pressure boiler of 430,000-lb. per hr. capacity and General Electric Co. will build the 40,000-kw., 3,600-r.p.m. turbo-generator (hydrogen cooled). When completed, the installation will be one of the largest steam turbine-generator units in New England. The boiler will be equipped to burn either coal or oil. The addition is expected to be in operation by the spring of 1939.

1250-lb. Testing Boiler

Clees Valve & Engrg. Co., 90 West St., New York, N. Y., is installing in its laboratories at Newark, N. J., a 1,250-lb. testing boiler, to be used for high-pressure equipment which this company is now manufacturing. The company will now have equipment facilities for testing apparatus up to 10,000 lb. per sq.in. hydrostatic pressure and 1,250 lb. steam pressure. Temperatures will be attained as high as 900 F. The facilities will be available for testing all types of equipment.

Boiler-Inspection Law In Effect in Texas

The compulsory boiler-inspection law recently passed by the Texas State Legislature has become effective, Aug. 1. Rules and regulations have been adopted by the State Labor Department, Austin, applying to all boiler installations now in service which come under the law, and all boilers installed in the future. Fees for inspection of boilers will be $7.50 for each internal inspection and $2.50 for each external inspection, a total of $10.00 for each boiler investigated.

Agents of insurance companies will be commissioned as "inspectors of steam boilers," upon passing an examination arranged by the State Bureau of Labor Statistics. External inspections will not be required more than once each year, unless investigation shows unsafe conditions or code violations. After 14 days' notice, the owner or user of a boiler subject to the law will be required to prepare the boiler for internal inspection or hydrostatic test.

Power Plant for "Leviathan" Replacement

Bids on the first ship to be built under supervision of the U. S. Maritime Commission will be opened Sept. 15. The ship, to cost between $13,000,000 and $15,000,000 will replace the U. S. Lines "Leviathan".

Power plant will consist of two sets of triple series turbines: high, low and intermediate; high-pressure turbine at 3,300 r.p.m. with double reduction down to 128 r.p.m. at the shaft; intermediate and low-pressure turbines with single reduction to 128 r.p.m. Six boilers will supply steam at 425 lb. gage and 700 F at superheater outlet. Four 600-kw. d.c. sets will supply current to ship auxiliaries and lighting circuits. Freon units

will refrigerate cold boxes, cargo holds and storage spaces, and act as standby for the ship's air-conditioning unit.

Pump Research at California

University of California's Department of Mechanical Engineering has recently established a laboratory for the study of vertical-shaft pumps. Research work will include: deepwell and propeller pumps, analysis of laboratory and field methods of testing, tests of motors, bearings and auxiliaries, tests of manufacturers' types and acceptance tests of specific pumps.

Arrangements have been made to borrow pumps and accessories for carrying on this research. Manufacturers interested should write to Prof. M. P. O'Brien, Dept. of Mech. Engrg., University of California, Berkeley, Calif.

Joint Engineers Meeting At Scranton, Pa.

Arrangements have been completed for a Joint Engineers Meeting to be held during Anthracite Week, in Scranton, October 9, 1937. It is sponsored by the local sections of the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the Chambers of Commerce in the Anthracite Field.

Speakers will be Cadwallader Evans, Jr., vice-president, Hudson Coal Co., Philip Sporn, vice-president and chief engineer, American Gas & Electric Co., and F. W. Earnest, president, Anthracite Industries, Inc.

The chairman of the Joint Engineers Committee is W. H. Lesser, Scranton, Pennsylvania.

OBITUARIES

THOMAS F. MAHER, 52, for the past six years president of Chapman Valve Mfg. Co., Indian Orchard, Mass., died unexpectedly at the Jane Brown Hospital, Providence, R. I., July 29, from a cerebral hemorrhage. Mr. Maher was born in Hartford, Conn., and entered the Chapman organization in 1909 in a minor capacity. With only a grammar school education, he rose steadily to the post of chief executive and a first-rank authority in his chosen field.

WALTER CARY, former vice-president of Westinghouse Electric & Mfg. Co., died recently from a heart attack in his home in New York City.

FREDERICK PAGE, president and founder of Frederick Page Contracting Co., boiler setters, died recently.

WILLIAM C. STETTINIUS, 41, a director of Worthington Pump & Machinery Corp., died in Baltimore, Md., July 20.

CHARLES S. HERSEY, 91, for 50 years plant engineer of the *Boston Evening Transcript*., until his retirement 16 years ago, died at his home in Dorchester, Mass., Aug. 1.

ADELINE GILES LOW, 78, wife of Fred R. Low, editor of *Power* for 42 years from 1888 to 1930, died Aug. 1 at Beech Hill Farm, Campton, N. H. Until Mr. Low's death, Jan. 22, 1936, the two were inseparable, both at home and in business.

HENRY M. BRUNDAGE, 64, former vice-president of Consolidated Edison Co., of N. Y., died July 17.

EUGENE YOUNG SAYER, 65, president of E. Y. Sayer Engrg. Corp., died at the Harlem Hospital in New York City Aug. 9. Active in electrical engineering work for 40 years, Mr. Sayer built the first plant that furnished power for trains ascending Pike's Peak.

PERSONALS

W. L. LUNDY, formerly mechanical engineer with Commercial Testing & Engrg. Co., Chicago, is now steam engineer in the Engrg. Dept. of Kimberly Clark Corp., Neenah, Wis.

W. H. SCHERER has been appointed manager of Worthington Pump & Machinery Corp.'s plant at Holyoke, Mass. Mr. Scherer goes to Worthington after 30 years with Westinghouse Electric & Mfg. Co., having been general supt. of Westinghouse's East Springfield Works for the past 18 years.

OWEN C. JONES, for the past 6 years with Linde Air Products, has been appointed assistant to president of Laminated Shim Co., Long Island City, N. Y. Mr. Jones will be in charge of sales promotion.

KERMIT K. FISCHER, formerly with Schutte & Koerting Co., has formed his own organization for manufacturing rotameters, the Fischer & Porter Co., 110 W. Penn St., Germantown, Philadelphia.

WILLIAM J. DAVIDSON has been appointed general sales manager of Winton Engine Corp. Mr. Davidson has been technical director under R. H. Grant, vice-president of General Motors in charge of Sales.

DAVE WILKUS has joined Harnischfeger Corp. as sales engineer for metropolitan Chicago.

SIMEON JESTER, JR., formerly with Sales Dept. of American Engrg. Co. at Philadelphia, has been transferred to Chicago as sales engineer.

LEON M. FUQUAY, for the past year and a half acting secretary of the Federal Power Commission, has been appointed secretary.

C. M. LEWIS, for many years associated with retail coal and domestic heating fields, has been appointed western zone manager for Whiting Corp.'s Stoker Div.

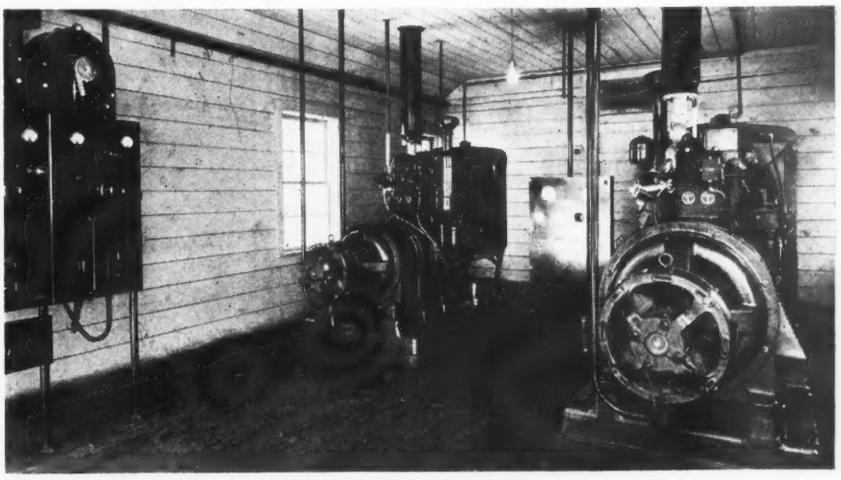
A. B. WHITEHOUSE, who has been actively identified with generating station development work and operation of electric plant for Lynn (Mass.) Gas & Electric Co. since the 1928 expansion program was undertaken, has been appointed superintendent of electrical distribution, succeeding O. M. Riggs.

PROF. HENRY KEITH has been appointed head of the department of naval architecture and marine engineering at the Massachusetts Institute of Technology, succeeding Prof. James R. Jack, who retired last year.

HENRY H. SEABROOK, JR., has been appointed assistant to H. J. Heineman, sales representative for Yarnall-Waring Co. in the Pittsburgh territory, and Fred Wetherill has joined the company as sales engineer in the Yarway Impulse Steam Trap Division.

WALTER A. SUTPHEN, district power sales engineer of New England Power Service Co., has become associated with Francis J. Sill, power plant and industrial consulting engineer at Westboro, Mass.

DR. EARL G. STURDEVANT has been appointed consulting engineer for U.S. Rubber Products, Inc., Electrical Wire and Cable Dept. Dr. Sturdevant has been associated with U.S. Rubber Products, Inc., since 1929, and since 1931



CENTRAL STATION UP IN THE AIR

At an altitude of 5,600 ft., Caterpillar diesels are direct connected to GE 60- and 25-kw. generators at the plant of Boise-Payette, Inc., Boise, Idaho. 3-phase, 60-kw. generator de-rated to 50 kw. because of high altitude. Plant runs 24 hours per day operating machine shop and lighting 70 dwellings and 12 other buildings

has been development manager of the Electrical Wire and Cable Dept.

CARL E. SPROUT has been appointed an associate of B. W. Sayer, district manager of the Portland, Ore. office of the Foxboro Co. Martin Rieger, Jr., has joined Foxboro's New York offices as a specialist in the Pyrometer Div.

C. C. JORDAN, sales engineer for the past 10 years in the Steam Turbine Div., Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been appointed assistant manager of that division.

J. P. BOORE, formerly vice-president of Summerill Tubing Co., has been named assistant general sales manager of Babcock & Wilcox Tube Co., Beaver Falls, Pa.

J. Y. DAHLSTRAND has been appointed sales representative in Burlington, Iowa, for Ward Leonard Electric Co., Mt. Vernon, N. Y.

FLOYD L. GREENE was recently elected president of General Refractories Co., Philadelphia, Pa. At the same time, announcement was made of the election of S. M. D. Clapper as chairman of the board. Mr. Greene was general superintendent of Standard Refractories Co. at the time of its acquisition by General Refractories in 1922, and became successively district manager of central Pennsylvania operations, general works manager, vice-president in charge of operations, and executive vice-president.

S. L. CORDIS has been appointed branch manager of the Seattle, Wash., branch office of York Ice Machinery Corp., York, Pa. Also, it was recently announced that Marshall G. Munce has been named managing director of York Shipley, Ltd., London, England, English affiliate of York Ice Machinery Corp.

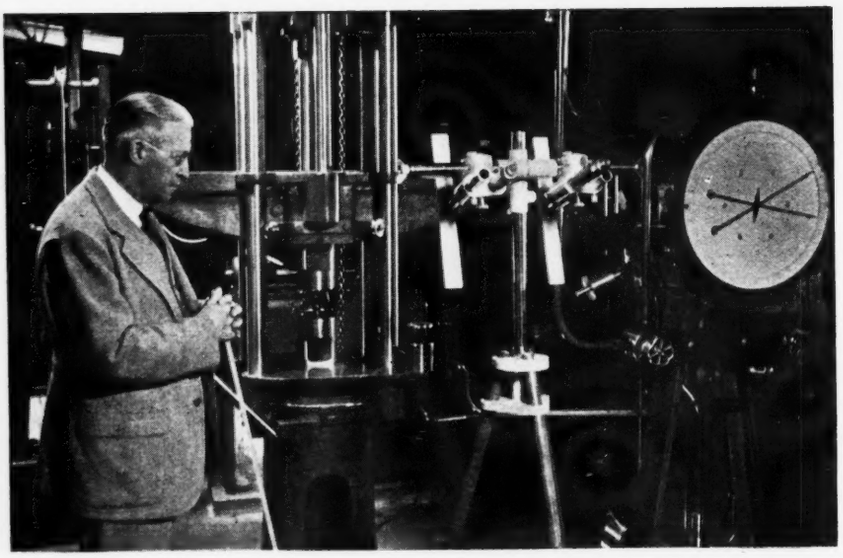
E. B. ELVETH has been appointed vice-president and general manager of Brown Instrument Co., Philadelphia, Pa., succeeding William J. Hejek who retired May 24 because of ill health.

FREDERICK E. KEY, vice-president of Key Co., East St. Louis, Mo., was given the honorary degree of Doctor of Mechanical Engineering recently by the University of Tulsa, in recognition of Mr. Key's extensive research in the oil-refining and steam-plant fields.

HARVEY T. HARRISON has been named sales manager of The Duraloy Co., with headquarters at the main office and plant, Scottdale, Pa.

J. J. SUMMERSBY, assistant vice-president of Worthington Pump & Machinery Corp., has been made general sales manager. Mr. Summersby has been with Worthington since 1920.

ALTON C. CHICK, engineer of the Manufacturers & Mutual Fire Insurance Co., Providence, R. I., has been elected president of the Providence Engineering Society, succeeding Clark Freeman.



DOWN TO A FINE POINT

W. W. Crawford, president of Edward Valve & Mfg. Co., looks over new Amsler tensile-testing machine. Since photo was taken, auxiliary Swiss equipment for high-temperature pulsating fatigue has been added. The Amsler-Martens mirror extensometer attachment will measure to 0.001 mm. (0.00004 in.)

FREDERICK E. BARTH, vice-president of Graton & Knight Co., Worcester, Mass., has been elected president to succeed the late Frank H. Willard. Mr. Barth entered the industrial field in 1914 as a staff member of the L. L. Harr Corp., New York, N. Y. In 1917 he went to Worcester to perfect production methods for Graton & Knight, and two years later was made office manager. In 1924 he was appointed general sales manager and in 1926 vice-president.

CHARLES W. E. CLARKE has rejoined United Engineers & Constructors, Inc., Philadelphia, Pa., as consulting engineer.

S. D. BARR, former New York manager of sales for Graver Tank & Mfg. Co., Chicago, has joined McClave-Brooks Co., Scranton, Pa., as New York district sales manager. Headquarters are at 92 Liberty St., New York, N. Y.

W. H. BLACKMER has resigned as sales manager of Laminated Shim Co., Inc., to become vice-president and general manager of Packless Metal Products Corp., Long Island City, N. Y.

HARRY SCHIELDS, Manchester, N. H., was elected president of the New England States branch of the N.A.P.E. at the annual meeting in Cambridge, Mass.

H. M. WESTERGAARD, who was named Gordon McKay professor of engineering at Harvard last fall, following 20 years on the Engineering faculty at the University of Illinois, has been appointed Dean of the Harvard Graduate School of Engineering, succeeding Dean Harry E. Clifford, who became emeritus this year.

LEON B. EICHENGREEN was recently elected a vice-president of the Philadelphia Electric Co. He will be in charge of activities in connection with gas properties of the company.

BUSINESS ITEMS

IRON & STEEL PRODUCTS, INC., has moved to its recently acquired 27-acre plant site at E. 135th St., Chicago. Also, a Pittsburgh office has been opened, in charge of C. W. McKirdy.

MERCOID CORP., Chicago, has opened a new office at 1035 Cathedral St., Baltimore, Md., in charge of John Jex, Jr.

IDEAL COMMUTATOR DRESSER CO., Sycamore, Ill., has bought out the "Revolution Counter" business of Belden Mfg. Co., and will manufacture this product at Sycamore.

AMERICAN ENGRG. CO. has moved its Cincinnati office to 1112 Chamber of Commerce Bldg. Also, Sabin Engrg. Co. has been appointed representative for "Lo-Hed" hoists in Cleveland.

W. H. NICHOLSON & Co., Wilkes-Barre, Pa., has appointed Bradshaw & Co., representative in Pittsburgh, and A. M. Seymour, 29 Hillsboro Rd., Rochester, N. Y., for Rochester and Syracuse, N. Y.

IRONTON FIRE BRICK CO., Ironton, Ohio, has appointed Warren C. Drake, 21 West St., New York, N. Y., representative in the New York territory.

LINCOLN ELECTRIC CO., Cleveland, Ohio, has opened a sales engineering office in Dayton, Ohio, at 1508 Watervliet Ave., A. P. Sharer, formerly with Firestone Tire & Rubber Co., will be in charge of the new office.

ROLLER-SMITH CO., 233 Broadway, New York, N. Y., has made the following appointments: H. D. Seaton, Volunteer Bldg., Chattanooga, will act as representative in Tenn.; Ward Engrg. Co., 1052 E. Bay St., Jacksonville, representative for Florida.

JOHNS-MANVILLE, New York, N. Y., announced following promotions: A. R. Fisher, J. P. Kottcamp and Alexander Cromwell have been elected vice-presi-

dents of the corporation; J. E. Begert, formerly head of the Cost Reduction Dept. in New York City, has succeeded Mr. Fisher as manager of the plant at Manville, N. J.; K. W. Huffine has succeeded Mr. Kottcamp as manager of the Waukegan, Ill., plant; H. J. O'Brien, formerly supt. of the Rock Wool Dept. at Manville has become manager of the Alexandria, Ind., plant; and W. Kelty, who was assistant to Mr. Begert in the Cost Reduction Dept., succeeds him as manager.

CHICAGO PNEUMATIC TOOL CO., New York, N. Y., has moved its Buffalo office to 128 W. Chippewa St.

GENERAL REFRACTORIES CO., Philadelphia, has appointed M. D. Larkin Co., distributor for Dayton, Ohio.

FOOTE BROS. GEAR & MACHINE CORP., Chicago, has appointed Eugene D. Wilson, 703 Columbian Mutual Tower, Memphis, Tenn., as representative for that territory.

WESTINGHOUSE ELECTRIC & MFG. CO., has acquired the A. B. See Elevator Co., New York, N. Y.

GAMLEN CHEMICAL CO. has moved its offices to larger quarters at 236 Fremont St., San Francisco, Calif.

GENERAL REFRACTORIES CO., Philadelphia, Pa., has announced appointment of Tennessee Mill and Mine Supply Co. as distributor for Knoxville, Tenn.

MASON-NEILAN REGULATOR CO., Boston, Mass., has opened a branch office in Los Angeles, Calif., at 1457 S. Concord St.

CATERPILLAR TRACTOR CO., Peoria, Ill., has made the following promotions and additions: Louis B. Neumiller, former manager of the Central Sales Division, has been named director of industrial relations; Leonard J. Fletcher, former head of the Agricultural Sales Division, has been made assistant general sales manager; C. M. Burdette, former assistant to Mr. Neumiller, has been advanced to manager of Central Sales Division; Charles A. Spears, who has been supervisor of special representatives, is now manager of Allied Equipment Sales; Merwin T. Farley, eastern sales supervisor, has been promoted to agricultural sales manager of the Eastern Division; and Floyd E. Rusher, former agricultural sales manager, succeeds Mr. Burdette as assistant sales manager of the Eastern Division.

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., has appointed the following zone representatives: E. E. Horn, Marietta, Ga.; G. P. Schumacker, Cleveland, Ohio; Chester E. Wing, Cincinnati; James T. Castle, Pittsburgh; and E. A. McCallum, San Francisco.

AMERICAN-MARSH PUMPS, INC., is the new name of American Steam Pump Co. Headquarters are in Battle Creek, Mich.

WESTINGHOUSE ELECTRIC & MFG. CO. has opened new executive, sales and lamp division offices at 306 4th Ave., Pittsburgh.

PENNSYLVANIA PUMP & COMPRESSOR CO. has appointed General Engrg. Equipt. Co., 578 Century Bldg., representatives for Indianapolis, Ind.

MECHANICAL GOODS DIV. of the U.S. Rubber Products, Inc., has transferred C. W. Gilmer from Seattle, Wash., to the New York office as belting sales engineer. L. F. Koepp, formerly salesman in the Seattle district, has been appointed manager of mechanical sales to take Mr. Gilmer's place.

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., has appointed the following zone representatives: Carl B. Sunderland, Muncie, Ind., covering Indiana, Ohio, Michigan, Illinois and Kentucky; J. J. Heinrikson, Kansas City, Mo., covering western Missouri, Kansas, Nebraska, and southwestern Iowa; and Paul C. Rowe, Newark, N. J., covering northern New Jersey.

HANLON-WATERS, INC., Tulsa, Okla., has opened a district office at 915 Old Colony Bldg., Chicago, headed by A. J. Foley, sales engineer.

C. O. BARTLETT & SNOW CO., Cleveland, Ohio, has moved its New York City offices to Room 404-E, 30 Church St. C. W. Ross, district manager, continues in charge.

CENTURY ELECTRIC CO. has moved its New York City offices from 50 Church St. to larger quarters in the Underwood Bldg., 30 Vesey St.

HYMAN MICHAELS CO. has moved its general offices from 20 N. Wacker Drive to Suite 1825, 122 S. Michigan Ave., Chicago.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has opened an office in the National Bank Bldg., Knoxville, Tenn., in charge of W. C. Johnson.

CUTLER-HAMMER, INC., Milwaukee, Wis., has opened branch offices in Dallas, Texas, at 624 Santa Fe Bldg., and in Youngstown, Ohio, at 1106 Central Tower. E. J. Gove is in charge of the latter office.

EX-CELL-O AIRCRAFT & TOOL CORP., Detroit, Mich., recently changed its corporate name to Ex-Cell-O Corp., and has appointed Williams and Wilson, Ltd., 544 Inspector St., Montreal, Canada, representatives for that district.

E. F. HOUGHTON & CO., Philadelphia, Pa., has announced organization of a research sales staff made up of five divisions: textile, industrial lubrication, metal working, leather, and leather oils and greases. The new department is headed by L. D. Holland, manager of marketing research.

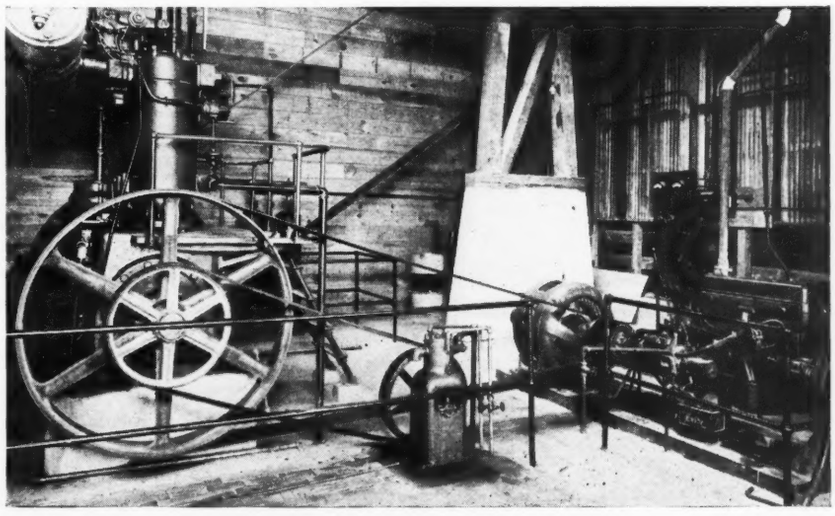
DAMPNEY CO. OF AMERICA has opened a branch office in Atlanta, Ga., at 425 Citizens and Southern National Bank Bldg., in charge of Ray W. Carter of Elkin, N. C., as Southeastern district representative.

MOELLER INSTRUMENT CO., New York, N. Y., has appointed as representative for western New York and northern Pennsylvania C. H. Mosher Co., 423 Ashland Ave., Buffalo, N. Y.

REVERE COPPER & BRASS INC., New York, N. Y., has opened a branch office at 410 Asylum St., Hartford, Conn.

YARNALL-WARING CO., Philadelphia, Pa., has moved its Cleveland offices from 30 Euclid Ave. to 1740 East 12th St.

WATTS REGULATOR CO., Lawrence, Mass., has moved into a new factory between Water and Essex Sts., about ½ mile from the location at 250 Lowell St., which this manufacturer and its predecessors occupied for 63 years.



THIS AUTO ENGINE TRAVELS NO MORE

Automobile engine (right), rebuilt by Meriam Co., Cleveland, Ohio, supplements a gas engine (left) at a Houston, Texas, plant. Main load is handled by a 150-hp. natural gas engine, having shaft extension and pulley at each end. The 6-cyl. auto engine is coupled through a splined shaft to the electric generator of the main engine

STRAWS

Pointing the way business winds blow

ALABAMA——W. W. Pickle & Canning Co., 98 Cooper St., Birmingham, plans steam power house at canning plant near Dallas, Tex. Cost over $60,000.

Galloway Coal Co., Carbon Hill, plans power house for Hope Mine. Also coal tipple and compressor. Cost over $250,000.

ARIZONA——Westinghouse Electric & Mfg. Co. has been awarded contract to supply two more turbine generators for the Arizona wing of the Boulder Dam power house at $1,467,000.

Tucson Gas, Electric Light & Power Co., Tucson, has authorized welded-steel pipeline from Park Ave. to Desert Sanitarium, about 5½ miles, for natural gas supply. C. H. Webber, superintendent, in charge.

Ajo Public School District, Ajo, plans central-heating plant for school district, boiler units to be gas-fired. Lescher & Mahoney, Title & Trust Bldg., Phoenix, architects.

CALIFORNIA——Metropolitan Water District, 306 W. 3rd St., Los Angeles, is building 17.4 miles of welded-steel pipe for Palos Verdes feeder line of Colorado River Aqueduct. F. E. Weymouth, general manager and chief engineer.

Bakersfield contracted Pomona Pump Co., Pomona, for motor-driven pumping unit and accessories.

Metro-Goldwyn-Mayer Studios, Inc., Culver City, contracted Myers Brothers, 3407 San Fernando Rd., Los Angeles, for 1-story power plant, 91x139 ft. Cost over $70,000.

Pacific Gas & Electric Co., 445 Sutter St., San Francisco, contracted Lindgren & Swinnerton, Inc., Standard Oil Bldg., San Francisco, for 10- and 12-in. welded-steel pipelines from Rio Vista gas field district to Woodland. Cost about $900,000

COLORADO——School District No. 2, Loveland, plans central-heating plant in 2-story junior high school. Cost about $285,000. Robert K. Fuller, Insurance Bldg., Denver, architect.

Albany Hotel Co., Denver, plans central-heating plant. Also air-conditioning and refrigerating system. Cost about $600,000.

CONNECTICUT——Union School District, Unionville, plans central-heating plant in 2-story school in Farmington district. Cost about $250,000. William T. Marchand, 26 Pearl St., Hartford, architect.

Winchester Arms Co., New Haven, purchased from Riley Stoker Corp. two 75,000-lb. per hr. boiler units. Western Cartridge Co., E. Alton, Ill., also bought two units of same size. All will operate at 725 lb. pressure and 750 F., and will be pulverized-fuel fired.

GEORGIA——L. P. Maggioni & Co., 401 W. Bay St., Savannah, food packers and canners, plan steam power house at 1-story canning plant, 50x120 ft., to be erected on Yonge's Island, S. C. Cost over $45,000.

Atlantic Co., 106 Washington St. Viaduct, Atlanta, plans addition to ice and cold storage plant. Cost close to $40,000.

Hotel Dempsey, Macon, H. M. Block, managing director, plans central-heating plant in 20-story building, office. An air-conditioning system will be installed. Cost about $450,000.

ILLINOIS——International Harvester Co., 606 S. Michigan Ave., Chicago, plans multi-story boiler plant, 50x192 ft., and 1-story compressor station at site of new plant at Indianapolis, Ind., to cost over $100,000.

Mechanics Universal Joint Co., 18th Ave., Rockford, plans 1-story boiler house, 60x100 ft. Cost over $200,000.

INDIANA——Richmond plans extensions in municipal electric plant, including high-pressure steam boiler with accessories, stoker, and coal bunker. Cost about $100,000. D. C. Hess, superintendent.

IOWA—Indianola has approved plans for extensions in municipal power plant, including 750-bhp. diesel. H. S. Nixon, 5023 Burt St., Omaha, Neb., engineer.

Primghar will take bids soon for municipal electric plant. Cost about $125,000. Buell & Winter Engrg. Co., Insurance Exchange Bldg., Sioux City, consulting engineer.

SYNCHRONIZING RELAY

Dr. Philip Thomas, Westinghouse research engineer, inspects a vacuum-tube synchronizing relay used to bring a generator into synchronism with a power system when more power is needed on the line

New Market plans municipal diesel plant. Fund of $55,000 arranged. A. S. Harrington, Baum Bldg., Omaha, Neb., engineer.

John Morrell & Co., Ottumwa, will build 4-story cold storage and refrigerating plant at branch meat-packing plant at Sioux Falls, S. D., 104x122 ft. Cost over $125,000. H. Peter Henschien, 59 E. Van Buren St., Chicago, architect and engineer.

Webster City contracted Allis-Chalmers Mfg. Co., Milwaukee, Wis., for a 2000-kw. condensing steam turbo-alternator, with accessories, one 30-kw. non-condensing steam turbine-driven exciter, at $52,800, and one 3600-sq. ft. surface condenser and auxiliaries, at $20,514, for municipal plant.

Bellevue contracted Worthington Pump & Machinery Corp., Harrison, N. J., for 1500-hp. diesel-generator unit with accessories, at $35,415, for municipal power plant. Young & Stanley, Inc., Muscatine, consulting engineer.

Walter Martin, Waukon, heads project to construct and operate a 1-story cold storage and refrigerating plant, to include 15-ton ice machine. Cost close to $45,000.

Federated Co-operative Power Assn, Iowa Falls, contracted Nordberg Mfg. Co., Milwaukee, Wis., for 3 diesel-generating units and auxiliaries, total capacity 2750-hp., at $191,968. Station will be located near Hampton, Iowa.

KANSAS——Russell plans pumping plant on Smoky Hill River, where new water source will be developed. Bids will be asked soon. Bond issue of $127,000 has been approved. Black & Veatch, 4706 Broadway, Kansas City, Mo., engineers.

McPherson will place contracts soon for high-pressure boiler unit and auxiliaries. Burns & McDonnell Engrg. Co., 107 W. Linwood Blvd., Kansas City, Mo., consulting engineer.

KENTUCKY——Fulton plans municipal electric plant to be operated in conjunction with waterworks pumping station. Will include two diesel engines.

LOUISIANA——Standard Oil Co. of Louisiana, St. Charles Ave., New Orleans, plans welded-steel pipeline from Roanoke to oil refining plant at Baton Rouge, with two branch welded-steel pipelines. Cost close to $1,500,000. J. M. Rathbone, president.

French Market Corp., New Orleans, plans refrigerating plant in fish-market building, 50x200 ft. Cost about $50,000. Sam Stone Jr. & Co., Inc., Masonic Temple Bldg., New Orleans, architect.

MARYLAND——Bureau of Yards and Docks, Navy Department, contracted William F. Kirwan, 432 N. Calvert St., Baltimore, for boiler-plant equipment and piping at U. S. Naval Academy, $28,700.

MASSACHUSETTS——Monarch Life Insurance Co., 74 Maple St., Springfield, contracted Holyoke Valve & Hydrant Co., 150 Race St., Holyoke, for heating and ventilating installation in 2-story office building on State St., Springfield. Cost about $275,000. Carl J. Malmfeldt, Hartford, Conn., architect.

Salem Oil & Grease Co., 60 Grove St., Salem, plans 1-story boiler house at plant. Henry N. Otis, 220 Locust St., Danvers, Mass., architect.

MICHIGAN——Ford Motor Co., Dearborn, contracted Koppers Co., Koppers Bldg., Pittsburgh, Pa., for an additional battery of 61 coke ovens at River Rouge plant.

Baldwin Rubber Co., Pontiac, plans boiler house at mill. Cost over $25,000. L. J. Heenan, Pontiac, architect.

MINNESOTA——Independent Utility Co., Farmington, P. C. Records, president, plans steam-electric generating plant for central-station service. Cost over $150,000. Buell & Winter Engrg. Co., Insurance Exchange Bldg., Sioux City, Iowa, consulting engineer.

Land O'Lakes Creameries, Inc., 2201 N. E. Kennedy St., Minneapolis, plans steam power house and cold-storage plant at Lamberton. Cost close to $100,000.

Duluth plans 4 electric-operated pumping plants for sewage disposal system. Bids will be asked soon.

MISSOURI——Missouri State Building Commission awarded following contracts in connection with state institutions: power plant building, State Sanatorium, Mt. Vernon, McCarthy Bros. Const. Co., St. Louis, $48,284: power-plant piping at State Hospital No. 4, Farmington, Ferguson Plumbing Co., $53,229; boiler settings at State Hospital No. 4 and State Sanatorium, D. Seegar & Sons, St. Louis, $14,625; power-plant piping at State Sanatorium, Industrial Heating & Plumbing Co., St. Joseph, $64,733; boiler for State Hosp. No. 2 St. Joseph Iron Wks., Burlington, Iowa, $20,518.

Board of Public Service, St. Louis, B. L. Brown, president, receives bids until Sept. 10 for 6-story psychopathic hospital, including heating and ventilating (estimated at $110,000), electrical work (estimated at $65,000), and elevators (estimated at $40,000). Total cost about $1,500,000. Department of Bridges and Buildings, Albert Osburg, chief architect, and William C. E. Becker, chief engineer, in charge.

Board of Public Service, St. Louis, contracted Economy Equipment Co., 4526 Olive St., St. Louis, for combustion control and metering equipment for boiler house at City Hospital No. 1, at $12,950.

Raskas Dairy Co., 1313 N. Newstead Ave., St. Louis, plans 1-story boiler house addition, 25x55 ft. Cost close to $30,000.

MONTANA——**Havre contracted J. L. McLaughlin Co., Great Falls, for pipeline system for municipal gas distribution at $117,173. C. O. Moore, Havre, engineer.**

NEBRASKA——**Holdredge will soon let contract for diesel-generator unit and auxiliaries. Cost about $68,000. Robert Fulton, 2327 S. 19th St., Lincoln, Neb., engineer.**

NEW HAMPSHIRE——**White Mountain Power Co., which includes recent consolidation of power companies in Alton, Goodrich Falls, Hill, Meredith, Pernigewassett and Plymouth, has been purchased by Arthur S. Dewing of Cambridge, Mass.**

NEW MEXICO——**Lordsburg has engaged Headman-Ferguson, Inc., Phoenix, Ariz., to prepare plans for municipal gas-distribution system. Bids will be asked soon. Fund of $127,000 for project.**

NEW YORK——**Worthington Pump & Machinery Corp., Harrison, N. J., has been awarded contract for pumps and gas engines at $469,000 for Tallman's Island Sewage Treatment Works, New York City Dpt. Of Sanitation. Contract calls for 4 centrifugal pumps (total combined daily capacity of 100,000,000 gal.) and 8 gas engines ranging from 180 to 800 hp. to operate on sewage gas developed by plant. Four engines will drive centrifugal pumps and others, rotary blowers.**

Department of Public Markets, New York, plans refrigerating plant in municipal market at First Ave. and E. 10th St. Cost close to $230,000. Lewis & Churchill, 250 Park Ave., New York, architects.

NORTH CAROLINA——**R. L. James & Son, Marion, have approved plans for boiler house at knitting mill. Cost about $25,000.**

OHIO——**Napoleon plans addition to municipal power plant, including boiler unit and auxiliaries. Cost about $30,000. Froehlich & Emery Engrg. Co., Second National Bank Bldg., Toledo, consulting engineer.**

State Department of Public Welfare, Columbus, will award contract soon for 300-kw. engine-generator unit and auxiliaries for power house at State Hospital, Toledo.

Board of Trustees, Wilberforce University, Xenia, plans steam power house at institution. Funds through Federal aid.

Nelsonville plans improvements in municipal power plant. Cost about $90,000.

Gus Juengling & Son, 2869 Mass. Ave., Cincinnati. plan refrigerating system in addition to meat plant, 33x55 ft. Cost close to $50.000. Wilkens & Gross, 1107 Bates Ave., architects and engineers.

Athens plans generator unit and auxiliaries for municipal plant. Cost about $90,000.

State Dept. of Education, Columbus, plans extensions in power house at Miami University, Oxford, Ohio, including 15,000-sq.ft. boiler stokers, etc. Cost about $50,000. Fosdick & Hilmer, Union Trust Bldg., Cincinnati, Ohio, consulting engineers.

Standard Oil Co. of Ohio, Midland Bank Bldg., Cleveland, Ohio, has authorized welded-steel pipeline from Latonia to Cheviot, where improvements will be made, including steel tanks and pumping machinery. Cost over **$200,000.**

OKLAHOMA —— Anderson-Prichard Oil Corp., Oklahoma City, Cushing Refining & Gasoline Co., Cushing, Bell Oil & Refining Co., Tulsa, and Rock Island Refining Co., Duncan, plan jointly-owned welded-steel pipeline from Grandfield, Okla., to terminal on Mississippi River in Eastern Iowa, about 650 miles, for gasoline transmission. Booster pumping stations will be built at points along route. Cost over $5,000,000. Ford, Bacon & Davis, Inc., 39 Broadway, New York, N. Y., engineers.

Cities Service Pipe Line Co., Tulsa, plans about 5 miles of 16- and 18-in. welded-steel pipelines for extensions in present lines in Cotton Valley and Commerce.

OREGON——Inland Power & Light Co., Portland, has applied to Federal Power Commission for permission to enlarge its Cove hydroelectric plant on Crooked River. Proposed to build new diversion dam, headgates, and enlarge power house to increase installed capacity to 4,400 hp.

State Hospital Dept., Capitol Building, Salem, plans boiler house at new tuberculosis hospital in Portland. Cost $200,000.

State Hospital Dept., Salem, has approved plans for boiler plant and buildings at Eastern Oregon State Hospital at The Dalles. Cost about $164,000. Jones & Marsh, Woodlark Bldg., Portland, architects.

Beard of Multnomah County Commissioners, Portland, contracted H. C. Hastorf, Inc., 735 S. E. Morrison St., Portland, for addition to power house at $24,326.

PENNSYLVANIA——Laughner Oil & Gas Co., Inc., South Heights (Beaver County), plans extensions in welded-steel pipelines in parts of Allegheny and Beaver Counties. Cost about $100,000.

Keasby & Mattison Co., Ambler, manufacturers of asbestos and magnesia products, are building a plant at Ambler for fabricating asbestos-cement pressure pipe. A second plant, to cost $500,000, will go into construction shortly at St. Louis, Mo.

RHODE ISLAND——Glenlyon Print Works, Phillipsdale, plans 1-story pumping station, 25x56 ft., at textile mill. Cost over $20,000. Charles T. Main, Inc., 201 Devonshire St., Boston, Mass., consulting engineer.

TEXAS——Bartlett Hayward Division of Koppers Co. has been awarded contract to supply twelve 102-in. cast-iron gates and conduit linings for Marshall Ford Dam at Rutledge Also a contract for fabrication and installation of 8 gates, each weighing 50 tons, and auxiliaries for Fort Peck Dam.

Red Bluff Water Power Control District. Pecos, E. B. Barron, president, plans improvements in power plant. Cost over $100,000. Financing through Federal aid. V. L. Sullivan, engineer.

Crane Independent School District, Crane, contracted David Vickers, Sweetwater, for central-heating plant. Cost close to $30,000. N. L. Peters, Glover-Crim Bldg., Longview, architect.

Deep Oil Development Co., Wichita Falls, contracted Cooper-Bessemer Corp., Grove City, Pa., for gas engine and compressor units for capacity of 900,000 cu.ft. per day, for natural gasoline plant in Wichita Valley district. Cost close to $90,000.

VIRGINIA——Charlottesville plans municipal power station. Estimates of cost will be made soon, Seth Burnley, city manager.

Manchester Board & Paper Co., Richmond, plans for 1-story boiler plant at mill on Hull St. Cost close to $30,000.

Northern Neck Electric Cooperative, Inc., Warsaw, contracted Perkins-Barnes Const. Co., Blackstone, for steam-electric power plant at Warsaw for rural electrification system. Cost about $184,000.

Water Department, Norfolk, has authorized installation of mechanical stokers in municipal water-pumping station at Moore's Bridges. $14,000 approved for this and pipeline for central steam-heating service in Municipal Welfare Center.

WASHINGTON —— Quinault Light Co., Hoquiam, Frank A. Gillett, president, plans hydroelectric plant on Ziegler Creek, near Lake Quinault. Cost over $75,000, with transmission line.

G. R. Kirk & Co., Perkins Bldg., Tacoma, plans 1-story cold-storage and refrigerating plant at Newport. Cost close to $30,000. E. J. Bresemann, architect.

Board of Trustees, Washington State College, Pullman, contracted C. C. Moore & Co., 450 Mission St., San Francisco, Calif., for boiler unit and auxiliaries for power house on campus, at $78,850.

WISCONSIN—Allis-Chalmers Mfg. Co., Milwaukee, has decided to spend between $3,000,000 and $4,000,000 on plant expansion and improvements during next year. Only step definitely decided upon so far is reconditioning of West Allis boiler house in Milwaukee at cost of about $800,000.

Walter Booth Shoe Co., 302 N. Broadway, Milwaukee, plans central-heating plant in new 2-story factory, 52x230 ft., at Waterloo, Iowa. Cost over $65,000. F. F. Droishagen, 647 W. Virginia St., Milwaukee, architect.

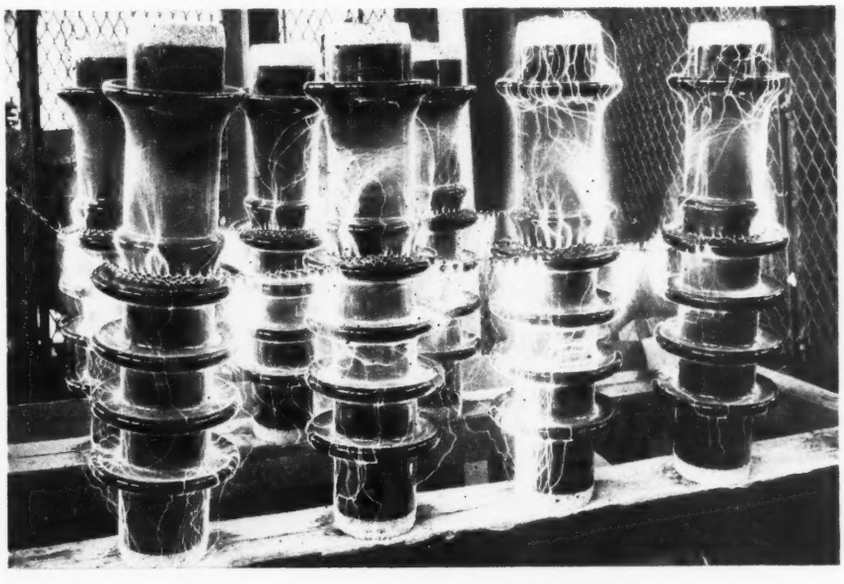
Kurth Malting Co., Greenfield, plans steam power house and buildings for malt plant. Cost about $1,000,000. L. E. Peterson, 312 E. Wisconsin Ave., Milwaukee, engineer.

Chili Milk Pool Cooperative, Inc., Chili, plans 1-story boiler house at milk products plant. Cost about $25,000. G. A. Krasin, Marshfield, Wis., architect.

Stella Cheese Co., Clayton, plans steam-electric power plant for factory. R. W. Richardson, Oppenheim Bldg., St. Paul, Minn., consulting engineer.

RAIN OF VOLTS

200,000-volt flashovers are part of the test given porcelain bushings at the Derry, Pa., Works of Westinghouse Electric & Mfg. Co. Tests are made to assure service of bushings and insulators in high-voltage transmission systems



TROUBLE LOG...

Sylvester McCafferty, the town nut, once invented a cast-iron harness for race horses. Right proud of it he was, too. Even had envelopes printed up with his name and a drawing of a horse wearing his harness—had to have it drawn because nobody could get his harness on a horse.

Trouble was, Sylvester hadn't had any experience with horses—he was going on guesses instead of knowledge. But then, Sylvester was to be pardoned—he was queer. Other people don't have that excuse.

What got Sylvester queer is a story too. He had a pretty but flibbertigibbet daughter that was forever falling in love with some fellow before he had time to fall in love with her. The last one turned out to be a married man, and with her worry and all, she jumped into the creek. She got into a jam, and didn't know how to get out. That girl was everything to Sylvester, and it about finished him too.

All of that us kids learned from her diary that we found when the town constable threw Sylvester out of his tarpaper squatter's shanty. We read that diary through and through, and her misfortune taught us some things to watch out for.

She at least told her troubles to her diary—but most of us are afraid to do even that. Our little triumphs and smartnesses we spread to anybody that'll listen, but difficulties are a different story—particularly if it's our own dumbness that causes them. Yet dumbness isn't limited to any one person—if we'd tell, we'd save somebody else the same grief.

One of my pet kid ambitions was to build a perpetual-motion machine. My idea was sort of based on the snake who started to eat his own tail and ate himself up. I took the first ten dollars I ever earned and bought three pieces of scrap shafting with bevel gears on each end, and a set of sleeve bearings. Then I set the shafts up in a triangle—the idea being that each gear would drive the next shaft until the last gear drove the first, and so on around. Believe me, that taught me something about friction! I could hardly turn the thing with a wrench!

There are a lot of more practical things that go haywire every day. Any number of engineers I know have had things go wrong. They'll admit the swell things that happen, but it usually takes a Merry Christmas and a Happy New Year to get them to admit the bad ones. Yet telling about troubles and the way they fixed 'em would certainly help other people.

Several years ago, *Power* published an article about all the jams one chief got into with a new boiler. That story taught me a lot, although it probably made the boiler manufacturer sore. Shouldn't have, though—it showed he knew how to fix things that went wrong, even on a brand new type of boiler. That chief kept a log, for himself as well as the men in his plant. Of course the log shows every so often that he's missed the boat, but it's there in cold black and white, and he'll never miss that particular boat again—and neither will anybody else if he can help it. And with the difficulty is the correction for it—if anybody else happens to face it again.

I don't want to be one of those newfangled psycho-something or others that gets paid for listening to other people's troubles. But I do want to hear more about what goes on backstage in a power plant. The nice things I can see; it's the bad things that really teach me something. So I'm pleading for trouble logs that are brought out into the open occasionally, to show what can go wrong and, more important, how it can be fixed. I'll bet the editors of *Power* would be glad to publish that kind of thing—if they could get it—and it would make good technical paper material too.

George Edwards

GEORGE EDWARDS,
Engineer

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(THIS ADVERTISEMENT APPEARS IN THE SATURDAY EVENING POST SEPTEMBER 11, 1937 ISSUE)

NEW BULLETINS

Pumps—Goulds Pumps, Inc., Seneca Falls, N. Y. 80-page catalog describes complete line of centrifugal, rotary and reciprocating pumps for industrial and general use. Very complete illustrations, specifications, charts and ratings.

Pumps—Lawrence Pump & Engine Co., Lawrence, Mass. 4-page bulletin No. D-46 on double ball-bearing, single-suction, centrifugal pumps for acids, alkalis, brines, hot or cold water, etc. Performance tables and dimensions.

Rebuilt Equipment—Belyea Co., Inc., 146 W. 18th St., New York, N. Y. 4-page catalog lists rebuilt motors, generators, converters, transformers, pumps, etc.

Relays and Timers—Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia. Mailing folder illustrates relays, timing devices, thermostats, electric counters, melting pots, ladles, etc.

Roofing—Johns-Manville, 22 East 40th St., New York, N. Y. 36-page catalog contains detailed specifications on "J-M Bonded Built-up" roofs. Specifications and drawings illustrate manner in which roofing materials are applied to various types of roofs.

Rotary Pumps—Roots-Connersville Blower Corp., Connersville, Ind. Two bulletins: No. 61-B10 on 3-lobe cycloidal pump for handling heavy liquids. Table of capacities, typical installations. No. 55-B10 covers application of rotary pumps as exhausters for priming larger centrifugal pumps, and includes size listings, installation views, and applications.

Safety and Relief Valves—Crosby Steam Gage and Valve Co., 30 Church St., New York, N. Y. 80-page catalog No. 101 describes nozzle safety and relief valves, showing construction, applications, proper installation, and many charts and tables.

Sheet Steel—Carnegie-Illinois Steel Corp., Pittsburgh, Pa. Descriptive Bulletin No. 1 describes "USS Electric Steel Sheets," showing production, testing, consumption, and application, which is mainly for the electrical industry.

Slip-Ring Motors—Century Electric Co., 1806 Pine St., St. Louis, Mo. 8-page Bulletin 1032 shows construction and application of slip-ring motors, 1 to 350 hp.

Squirrel-Cage Motors—Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland, Ohio. Bulletin sheet describes method of integrally casting end rings, fans and rotor bars of a.c. squirrel-cage induction motors to eliminate possibility of poor contacts or loose connections.

Steam Conduit System—H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. Illustrated booklet shows five steps in installing "Therm-O-Tile," which includes pouring of foundation, placing pipe supports, installing pipe, insulating the pipe, and finally installing the tile.

Stokers—Iron Fireman Mfg. Co., 3170 W. 106th St., Cleveland, Ohio. 16-page catalog on underfeed stokers for boilers developing up to 300 hp. Constructional features and applications illustrated.

Time Controls — Automatic Temperature Control Co., 34 E. Logan St., Philadelphia. Bulletin G-4 describes time-control devices for non-standard applications and illustrates four recent cases requiring specialized design.

Turbines—Terry Steam Turbine Co., Terry Square, Hartford, Conn. Bulletin S-116 describes Terry "Wheel," impulse, helical-flow turbines, designed mainly for non-condensing operation. Illustrations show construction, principle of operation, and steps in manufacture.

V-Belts—Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis, Ind. Catalog 795 gives complete price and application listing of Rockwood single-groove V-belts.

Valve Control—Philadelphia Gear Works, G St. below Erie Ave., Philadelphia. 48-page catalog, "Limitorque Control," describes principles of operation, construction, specifications, applications and installations. Well illustrated with drawings and photos.

Vibration Elimination—Felters Co., Inc., 210 South St., Boston, Mass. 32-page booklet, "A Study of Vibration in Plant Machinery," gives results of vibration studies and characteristics of wool felt as an eliminator.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ariz., Phoenix—Roosevelt Water Conservation Dist. applied for $1,125,000 grant and $1,375,000 loan from P.W.A. for construction of hydro-electric plant and attendant works at junction of Salt and Verde River, 30 mi. northeast of here. $2,500,000. Besides the power plant, the district contemplates construction diversion dam in each of rivers, 17 mi. large canals and approximately 8 mi. power transmission lines and necessary substations.

Ariz., Tempe—Bd. Council Salt River Valley Water Users' Assoc., Phoenix, will install foundations for huge Diesel engine and erect the building to house it; the plant is expected to be in operation by May, 1938. The new plant is to be built adjacent to present crossing canal plant near here. Total est. $550,000. Construction costs are to be paid out of revenues.

D. C., Wash.—Potomac Electric Power Co., 10th and E. Sts., N. W., plans constructing 2 story shop and service building, 2255 11th St., N. W. $350,000.

Ind., Richmond—City, D. C. Hess, plant supt., Municipal Power & Light Plant, plans boilers, enlarged bunkers, new generator to enlarge facilities of present electric power and light plant. $150,000.

Ia., Ames—State, Ames, plans improving power plant, steam distribution system and heating system at Iowa State College. $120,000. State Executive Council of Iowa approved expenditure.

Ia., Cherokee—Iowa Public Service Co., Sioux City, plans prepared by R. J. Mullins, archt. and engr., Sioux City, constructing power house and installing 1,400 hp. Diesel unit. $125,000.

Ia., Eldon—City Council plans constructing municipal electric light and power plant. $51,000.

Ia., Indianola—City making plans improving light and power plant, incl. Diesel engine, extra equipment, air intake, silencer, voltage regulators, etc. $46,000. H. S. Nixon, Omaha, engr.

Ia., Primghar—City, plans constructing power plant. To exceed $50,000. Buell & Winter, 508 Insurance Exchange Bldg., Sioux City, engrs.

Ia., Storm Lake—City, plans to construct municipal power plant. $330,000. Young & Stanley, Muscatine, engrs., made survey. City rejected proposal to extend Iowa Public Service Company's franchise.

Minn., Maple Plain — Rural Co-operative Power Assn. of Minnesota, c/o Federated Electric Co-operative, W. W. Cutcliffe, engr., 739 Johnson St., Minneapolis, making plans power house and electric generating plant to furnish power for REA projects in Hennepin, Wright, Carver, Scott and various other counties. $400,000. $200,000 REA allotment made.

Minn., Springfield—City, A. C. Mueller, clk., making preliminary survey furnishing, installing new equipment at municipal power plant, extension to heating mains, etc. To exceed $25,000 (not official). Burlingame, Hitchcock & Estabrook, 521 Sexon Bldg., Minneapolis engrs.

Neb., Broken Bow—City plans constructing distributing lines in city to cost $30,000 if Western Public Service Co. will not sell their lines in that city to the municipal power plant.

Neb., Superior—City on July 21, voted favorably to purchase plant of Nebraska Power Co., now serving the city, or to build a new plant to cost about $60,000 or more. C. P. Gregory, city clk.

Minn., Farmington—Independent Utility Co., P. C. Records, pres., granted franchise and plans power plant and distribution system. $120,000. Buell & Winter Eng. Co., 508 Insurance Bldg., Sioux City, Ia., engrs.

Miss., Hattiesburg—City, c/o Mayor, field survey in progress for new municipally-owned electric light plant. Burns & McDonnell, 107 West Linwood Blvd., Kansas City, Mo., engrs.

N. H., Manchester—State, Industrial School, North River Rd., plans by C. R. Whitcher, 512 The Beacon, 1 story, brick, steel boiler plant and shop, concrete found, at Industrial School, to exceed $40,000; 2 or 3 story, basement infirmary school at Industrial School, to exceed $150,000.

N. J., Burlington—Public Service Electric & Gas Co., 80 Park Pl., Newark, plans enlargement and improvement program, incl. extension power station to house 100,000 kilowatt turbine generator, high pressure boilers and auxiliary equipment. $12,000,000.

O., Columbus Grove—Village approved plans furnishing, installing two diesel engines with steam standby and other improvements as recommended by Burns & McDonnell, engrs., 307 East 4th St., Cincinnati, after recent survey of the light plant. $60,000. Council has authorized project which will be financed partly through revenue bonds and by $22,000 which is at present in water plant funds.

O., Dayton—Dayton State Hospital, Dayton, plans heating and power plant boiler and installation. $40,000.

O., Georgetown — City, B. H. Crawford, mayor, in charge of preliminary plans constructing electric light and power plant, $100,000.

O., Newton Falls—Village, D. M. Bailey, Jr., mayor, plans municipal light and power plant. Will sell $150,000 worth of bonds to finance project. Trumbull County Court of Appeal recently rejected appeal of Ohio Pub. Serv. Co., for an injunction to restrain village from selling bonds. Noted July 10, C.D.—July 16, E.N.-R.

O., Oxford—State, Columbus, plans improvement power plant at Miami University by installation 1,500 hp. boiler, stoker and piping. $50,000. **Fosdick & Helmer, engrs.,** Union Trust Bldg., Cincinnati, retained for project.

O., Wilberforce—Wilberforce University, R. R. Wright, plans improvements at university, incl. construction new power house. $140,850. W.P.A. project. Forest Holton, Wilberforce, ch. engr.

O., Willard—Village, preliminary plans improving municipal light and waterworks plant, incl. rebuilding structure containing water and light equipment. $16,000 appropriated. E. L. Wolff, mayor, in charge of preliminary plans.

Ore., Crooked River—Inland Power & Light Co., Public Service Bldg., Portland, plans constructing addition to hydro-electric power plant, incl. new diversion dam, new headgates and power house addition. To exceed $40,000.

Pa., Pittsburgh—Commonwealth of Pennsylvania, A. S. Janeway, dir., 600 North 2nd St., Harrisburg, sketches completed constructing power house with two 500 hp. boilers, 27th Ward. R. Irvin, Starr Bldg., 3rd Ave., engr.

Tex., Austin—Lower Colorado River Authority, c/o R. Fry, chn., Littlefield Bldg., soon takes bids repairing concrete spillway, repairing and elevating present dam, power plant and transmission lines at Lake Austin. If the agreement between the Lower Colorado River Authority and city of Austin is finally consummated the rehabilitation of the Austin Dam will cost approximately $1,000,000. C. McDonough, Littlefield Bldg., engr.

Tex., Pecos—Red Bluff Water Power Control Dist., c/o E. B. Barron, pres., plans power plant improvements, incl. transmission lines. power plant, etc. $200,000. Supplemental application approved by P.W.A. V. L. Sullivan, Orla, engr.

Wash., Electron—Puget Sound Power & Light Co., 7th and Olive Sts., Seattle, plans reconstructing power plant, damaged by landslide in November. $500,000. Work now underway on $100,000 project to temporarily house two of the four turbine units in frame and galvanized iron structures and to replace electric controls. Permanent reconstruction favored by engineers, would involve rein.-con. buildings, but has not yet been ordered because of unfavorable political attitude toward utilities. Work would be carried out by day labor under direction of engineers. Company also considering reconstructing 10 mi. timber flume over three year period at unestimated cost.

Wis., West Allis—Allis-Chalmers Mfg. Co., West Allis, plans reconditioning steam, electric power plant and boiler house. $800,000.

Ont., Belleville — Ontario Hydro-Electric Power Comn., Toronto, T. S. Lyon, chn., taking bids constructing transmission lines and a tie up connecting Qunite and Trent Valley Power Companies' plants at Frankford and Campbellford with Eastern Ontario system to provide additional 4,300 h.p. to the Trent Valley portion of system, also installing one small, new unit. $470,000.

Ont., Fort Francis—Ontario and Minnesota Power Co., Ltd., preparing plans for construction of grinder house. $150,000.

Ont., Fort William—Abitibi Power & Paper Co., plans plant improvements. $1,000,000.

Ont., St. Thomas—Ontario Dpt. P. Wks., Toronto, making plans power plant. $100,000.

Que., LaTuque—St. Maurice Power Co., Ltd., plans by engineering staff of Shawinigan Water & Power Co., Ltd., Power Bldg., Craig St., Montreal, for $15,000,000 power development on the upper St. Maurice River near here. Four vertical hydro-electrical units will be installed, capacity of each 40,500 h.p. at 104 ft. head of water and provision made for two additional units of the same capacity for later installation.

Que., Three Rivers—Shawinigan Water & Power Co. plans power plant addition and sub-station and power lines. $750,000.

Australia, Melbourne—Victoria Electric Commission voted $41,481,500 for constructing hydro-electric plant at Kiewa River. Plans being prepared by own staff and expect to be available before end of year. Those interested should file names with Secretary of Commission.